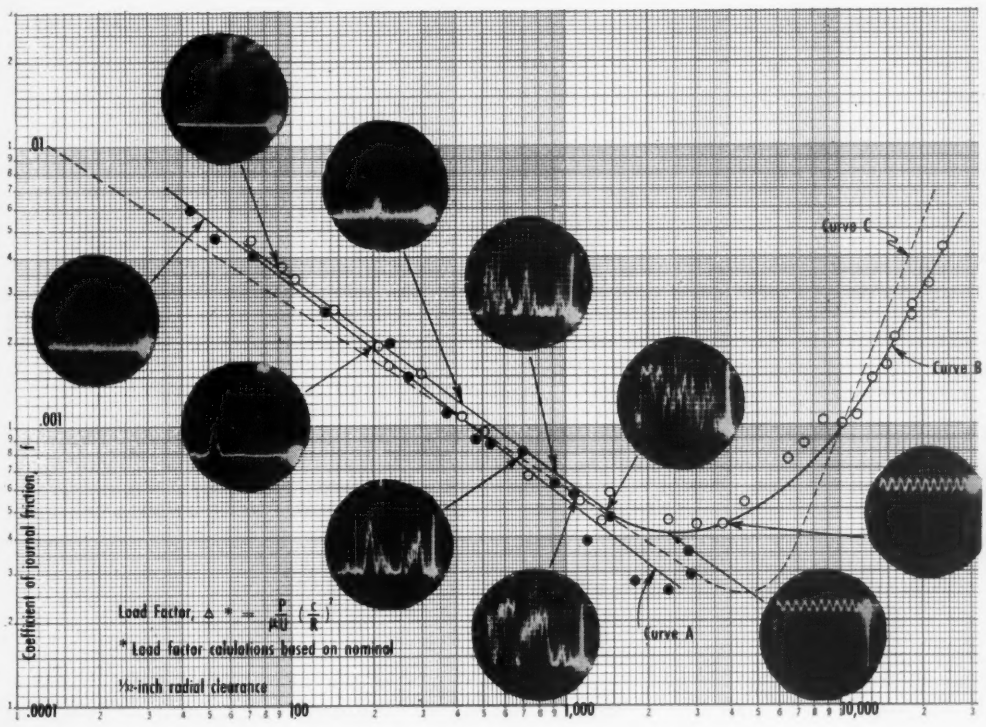
Vol. 13, No. 3 March, 1957

LUBRICATION ENGINEERING

RESEARCH APPLICATION EDUCATION MAINTENANCE

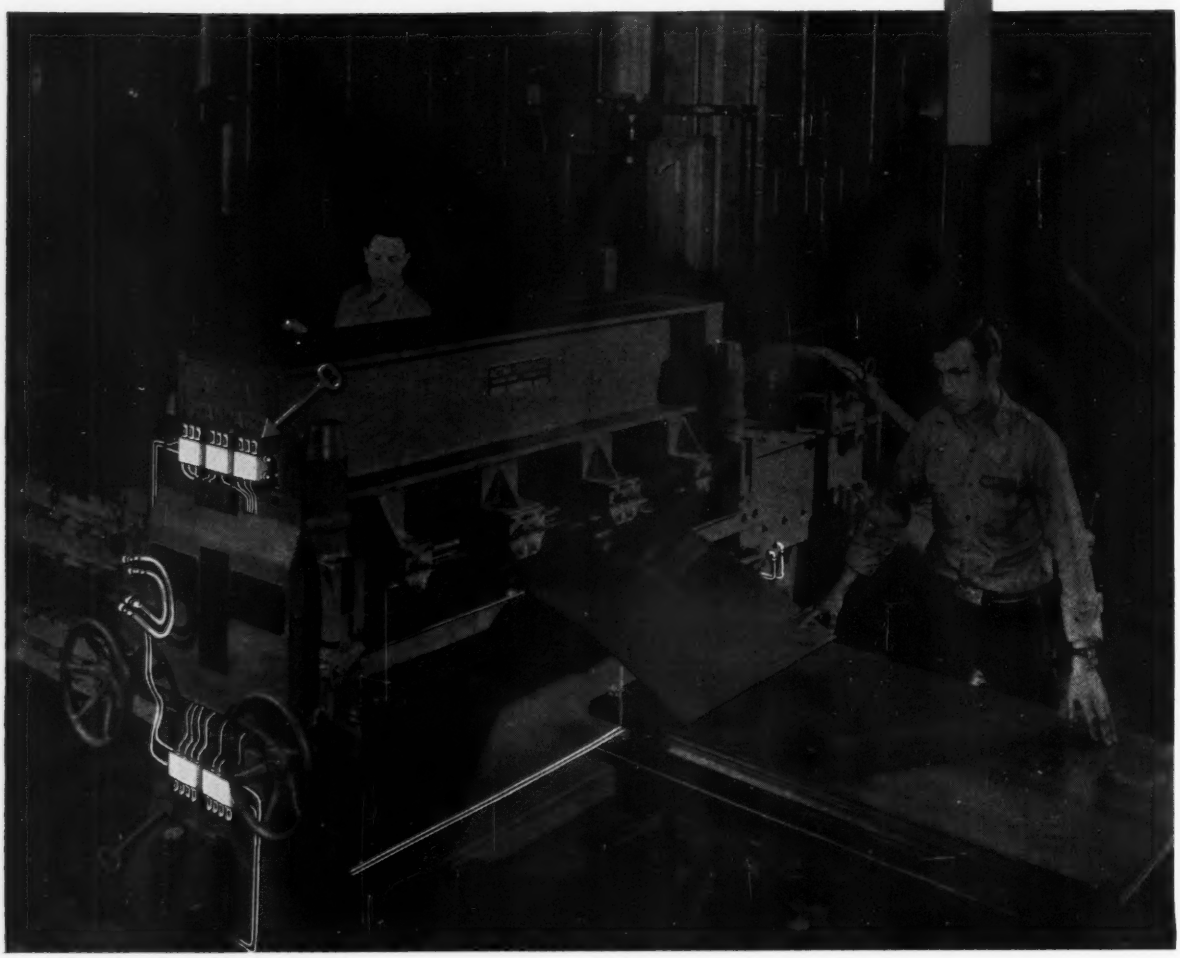


Friction Characteristics of a standard 6 x 11 railroad bearing well-seated in freight car service, with oscillograph patterns giving visual indication of various stages of oil film breakdown.

JOURNAL OF THE AMERICAN SOCIETY OF LUBRICATION ENGINEERS

Continuous, high-speed sheet levelling calls for continuous, precision lubrication

FARVAL—
Studies in Centralized Lubrication
No. 192



● Wherever high speed and heavy shock loads are involved, adequate lubrication of bearings is a must. It can't be a hit-and-miss proposition—there's too much at stake with costly machines and continuous production lines. The operation above is a good example. Here an Aetna-Standard sheet leveller flattens sheets at high speed. Failure or inaccuracy interferes with succeeding forming and stamping operations. With Farval on guard, such eventuality will not occur.

Farval delivers a measured amount of clean lubricant to every bearing at regular intervals. No bearings are ever missed—and the amount delivered to any bearing can be varied without affecting the rest of the system. Farval saves production hours, maintenance, labor.

Ask, now, for a free lubrication survey. Let us send one of our lubrication engineers to inspect your plant equipment. Without obligation, he will present a written analysis of what Farval can do for you. Write the Farval Corporation, 3267 E. 80th St., Cleveland 4, O.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.

KEYS TO ADEQUATE LUBRICATION—
Wherever you can see these Farval manifolds, dual lubricant lines and central pumping station, you know a machine is being properly lubricated.

Here, Farval serves an Aetna-Standard leveller in an Ohio metalworking plant.

LUBRICATION ENGINEERING

RESEARCH APPLICATION EDUCATION MAINTENANCE

Volume 13, No. 3

March, 1957

Table Of Contents

Prevention of Cutting Oil Dermatoses, The
by D. J. Birmingham 129

Surface Viscosity & Elasticity of Lubricating Oils
by D. W. Criddle 131

Radiation-Resistant Greases
by J. G. Carroll, R. O. Bolt & B. W. Hotten 136

Dual-Purpose Film Strength Additive for Engine Crankcase Oils, A
by G. C. Templeman 141

Dynamic Demulsibility Characteristics of Oils
by E. W. Brennan & R. G. Moyer 146

Disinfection of Soluble Oil Emulsions
by H. Pivnick & C. K. Fotopoulos 151

Advertisers' Index 168
ASLE Directory 116
ASLE News Notebook, compiled by R. D. McCormick 123
Coming Events 159
Cover Picture, courtesy Armour Research Foundation of Illinois Institute of Technology ..... Cover
Current Literature 156
Editorial: "The Society and the TAB," by S. R. Calish, Jr. 117
Foreign Lubrication Abstracts, compiled by Henry Brutcher 145
Lube Lines: "Compatibility of Lubricants in Service," by A. F. Brewer 127
Lubrication Abstracts, compiled by the ASLE Abstracts Sub-Committees 162
New Products 121
Patent Abstracts, compiled by Ann Burchick 160
Personals 119
Section News 140
The Sight Glass 114

LUBRICATION ENGINEERING is published monthly by the American Society of Lubrication Engineers, 84 E. Randolph St., Chicago 1, Illinois. Current-year single copies 75c; previous-years' single copies, if available, $1.00. Annual subscription $6.00 in the United States and Canada, $7.00 in all other countries.

Copyright 1957 by the American Society of Lubrication Engineers. ASLE will not be responsible for statements or opinions presented at its meetings or printed in its publications.

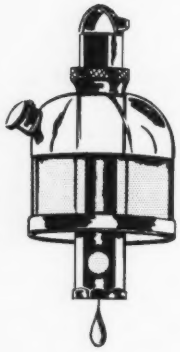
Editor ..... R. K. Gould, The Texas Co., Box 509, Beacon, N. Y.
Associate Editor ..... C. R. Kluge, ASLE National Office, 84 E. Randolph St., Chicago 1, Ill.
Consulting Editor ..... A. F. Brewer, Consultant
Advertising & Business Manager ..... C. L. Willey, ASLE National Office
ASLE Publications Manager ..... R. D. McCormick, ASLE National Office

Editorial Committee

R. K. Gould (Chairman), The Texas Co. ..... R. D. McCormick, ASLE National Office
F. R. Archibald, Arthur D. Little, Inc. ..... J. J. O'Connor, McGraw-Hill Publishing Co.
J. Faust, L. Sonneborn & Sons, Inc. ..... D. W. Sawyer, Aluminum Co. of America
R. H. Josephson, Cleveland Graphite Bronze Co. ..... S. K. Talley, Shell Development Co.
C. R. Lewis, Standard Oil Co. (Ind.) ..... A. C. West, California Research Corp.

Engravings by **Leader Engraving Co.**, Rochelle, Ill.
Printed by **Publishers Printing Co., Inc.**, 112-116 E. Chestnut St., Louisville 2, Ky.
(Second class mail privileges authorized at Chicago, Ill.)

The Sight Glass



Highlights of Articles Scheduled for Coming Issues!

Prevention of Industrial Dermatitis in a Motor Truck Plant

It is the responsibility of Plant Management to return each employee to his home free from injury to his person or to his health. In the procedure described each plant has its own committee of employees and management to inspect work areas and to ascertain that the employees are adequately protected against all suspected or known occupational disease hazards. Industrial hazards include both known hazards and unknown; coolants, solvents, cleaning compounds, and other agents proved to be harmless when properly used, may become contaminated or undergo a chemical change while in use, which cause them to become a health hazard. Plant pilot selection of new products and classification of dermatitis-sensitive employees together with a program of coolant control practices has materially reduced this company's industrial health hazards.

Cam & Tappet Test for Lubricants I — Anti-Scuff Evaluation

A bench-type lubricant tester is described for the study of metal scuff under combined sliding and rolling contact, with cyclic variation of load. Scuffing is characterized by the formation of deep grooves, rapid surface roughening, and welding and tearing away of the surface metal. The scuffing of a hardenable-iron tappet riding on a cast-iron cam is delayed by a run-in at a moderate load, or by the use of an oil containing a small percentage of the additive, zinc dialkyl dithiophosphate. A short run-in with the additive oil protects the parts against scuff, even when a non-additive oil is used subsequently.

A New Method for the Determination of Attitude & Eccentricity in Journal Bearings

Some of the most difficult yet most important measurements to be made in bearings are those of determining the attitude, eccentricity, and film thickness. A new method of measurement is described which measures the motion between a rigidly-supported shaft and a floating bearing. Three types of instruments were used to measure this motion. Since the work was accompanied with a stability analysis of journal bearings, only eccentricity ratios in the range from 0 to 0.5 were investigated.

Use of Rolling Contact Bearings in Low Viscosity Liquid Metal Lubricants

Tests were conducted on rolling contact bearings submerged in and lubricated by either liquid sodium-potassium alloy or liquid sodium to determine the effect of thrust load on the bearing with respect to bearing life. Various materials of construction and bearing design were used, and the effects of these variables were measured.

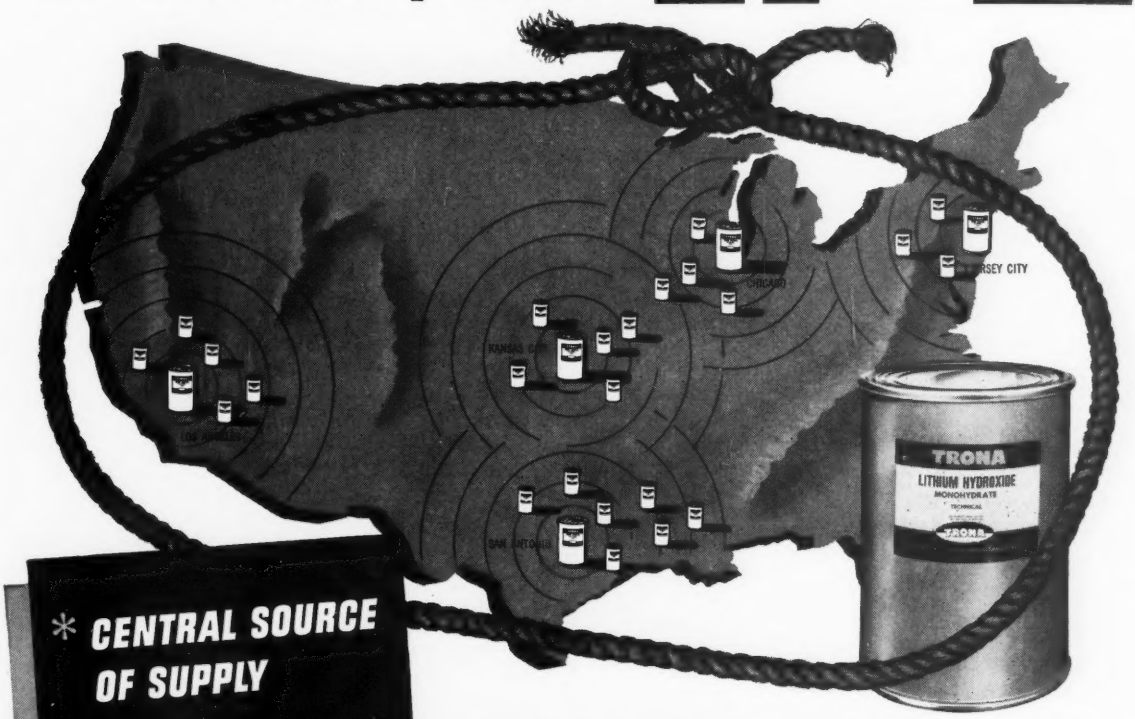
Numerical Solution of Reynolds' Equation for Sector Thrust Bearings

A method of solving the Reynolds' equation using digital computer techniques has been developed to predict sector bearing performance. The results compare favorably with experiment and known analytical solutions. The investigation indicates that good design criteria may be established for sector thrust bearings with arbitrary geometries, and possibly very accurate predictions may be obtained if the Reynolds' and energy equations can be solved simultaneously by this technique.

TRONA† LITHIUM HYDROXIDE

FOR MULTI-PURPOSE GREASES

...an essential product—tied in with service



* CENTRAL SOURCE OF SUPPLY
* STRATEGIC WAREHOUSING
* BETTER DELIVERIES

TRONA

GREASE MANUFACTURERS: There are three good reasons why Trona† should be your prime source of supply of lithium hydroxide monohydrate ($LiOH \cdot H_2O$), essential to the production of lithium base greases. (1) **A new and strategically located plant** at San Antonio, Texas (American Lithium Chemicals, Inc.). (2) **Convenient warehouse stocks** of lithium hydroxide, maintained in proximity to the major grease producing areas of the U. S. (see map). (3) **Better, faster deliveries,** because of advantageous rail and motor freight facilities. When planning your current, or future, requirements for LiOH we suggest you contact your American Potash & Chemical Corporation (Trona†) sales representative. His better service costs no more.

†TRADEMARK AP&CC

American Potash & Chemical Corporation

LOS ANGELES • NEW YORK • ATLANTA • SAN FRANCISCO • PORTLAND (ORE.)

Producers of: BORAX • POTASH • SODA ASH • SALT CAKE • LITHIUM CHEMICALS • BROMINE CHEMICALS • CHLORATES • PERCHLORATES • MANGANESE DIOXIDE *and a diversified line of specialized agricultural and refrigerant chemicals.*

Plants: TRONA and LOS ANGELES, CALIFORNIA
HENDERSON, NEVADA
SAN ANTONIO, TEXAS (American Lithium Chemicals, Inc.)
Export Div.: 99 PARK AVENUE, NEW YORK 16, NEW YORK

ASLE Directory

NATIONAL OFFICERS

President
E. R. Booser
General Electric Co.

Vice-President at Large
J. O. McLean
Reynolds Metals Co.

Secretary
J. L. Finkelmann
Chrysler Corp., Cycleweld Div.

Treasurer
J. W. Peterson
Standard Oil Co. (Ind.)

Administrative-Secretary
C. L. Willey
ASLE National Office

Chrmn., Presidential Council
J. W. Hopkinson
Penn-Petroleum Corp.

NATIONAL DIRECTORS

A. E. Cichelli
Bethlehem Steel Co.

D. M. Cleaveland
Bendix Aviation Corp.

J. H. Fuller
E. I. duPont deNemours & Co.

W. E. Lasky
Gulf Mobile & Ohio RR Co.

C. T. Lewis
Republic Steel Corp.

J. D. Lykins
Wheeling Steel Corp.

D. W. Sawyer
Aluminum Co. of America

C. R. Schmitt
E. F. Houghton & Co.

REGIONAL VICE-PRESIDENTS

M. E. Dougherty, (Eastern)
Acheson Colloids Co.

R. F. McKibben, (Central)
National Cash Register Co.

B. H. Miller, (Canadian)
Imperial Oil Co., Ltd.

L. M. Tichvinsky, (Western)
University of California

A. B. Wilder, (Midwestern)
E. I. duPont deNemours & Co.

AREA REPRESENTATIVES

Boston/Connecticut ..... H. A. Wilson, Commercial Filters Corp., 30 Coolidge Ave., Lexington, Mass.
Buffalo/Schenectady/Syracuse ..... D. F. Wilcock, General Electric Co., Gen. Engrg. Lab., 1 River Rd., Schenectady, N. Y.
Chicago/Milwaukee/Rockford ..... F. J. Schmitt, D. A. Stuart Oil Co., 2727 S. Troy St., Chicago, Ill.
Cleveland/Youngstown ..... A. H. Turner, Standard Oil Co., Midland Bldg., Cleveland 15, Ohio
Columbus ..... H. W. Irion, National Refg. Co., 1885 Coventry Rd., Columbus 12, Ohio
Dayton/Cincinnati ..... G. H. Leffel, D. A. Stuart Oil Co., 1021 N. Limestone St., Springfield, Ohio
Houston/Dallas/Fort Worth ..... F. A. Rudolph, Sun Oil Co., 840 Rio Grande, Dallas 1, Tex.
Indianapolis/Fort Wayne ..... D. H. Wilson, Continental Steel Corp., South Plant, Kokomo, Ind.
Kansas City/St. Louis ..... C. J. Smith, Cities Service Oil Co., 406 W. 34th St., Kansas City, Mo.
Los Angeles ..... R. C. Dishington, General Petroleum Corp., 2401 E. 27th St., Los Angeles 54, Calif.
New York/Baltimore/Philadelphia ..... M. E. Dougherty, Acheson Colloids Co., 1423 Land Title Bldg., Philadelphia 10, Pa.
Pittsburgh/Wheeling ..... J. P. Critchlow, Gulf Oil Corp., Gulf Bldg., Pittsburgh 30, Pa.
Seattle/Washington ..... J. Hood, Boeing Airplane Co., 2906 - 39th Ave., SW, Seattle 16, Wash.
Twin Cities/Duluth/Iron Range/Davenport/Rock Island/Des Moines/Cedar Rapids ..... R. O. Erickson, Shell Oil Co., 5516 Glengarry Pkwy., Minneapolis 24, Minn.
Western Rocky Mountain ..... D. P. Thomas, Columbia-Geneva Steel Div., U. S. Steel Corp., P. O. Box 510, Provo, Utah

SECTION OFFICERS

	CHAIRMAN	VICE-CHAIRMAN	SECRETARY	TREASURER
Baltimore	J. E. Buchanan	R. L. Humphreys	C. J. Devries	H. A. Rau, Jr.
Boston	H. G. Senning	R. S. Jackman	E. G. Jackson	G. T. Collatz
Buffalo	V. Steele		J. A. Eckhardt	R. C. Sager
Central Ohio	H. W. Irion	E. E. Smith	M. Ray	M. Ray
Chicago	R. G. Grothus	J. N. Waddell	E. W. Drummond	E. W. Drummond
Cincinnati	R. W. Smith	G. E. Brown	E. L. Curtis	E. L. Curtis
Cleveland	E. F. Rost	J. W. Hurley	G. L. Smith	W. A. Ursem
Connecticut	P. Faxon	N. E. Shirk	L. Edwards	C. E. Pratt
Dayton	E. C. Briggs	H. L. Sellers	H. A. Bradley	A. G. Horvath
Detroit	J. A. Brady	T. Cabba	C. F. Cowley	R. L. Leslie
Duluth/Iron Range	R. D. Keech	R. Rutka	C. D. Johnson	W. Kiriluk
Fort Wayne	C. R. Griffith	J. W. Sites	J. M. Olson	J. M. Olson
Houston	M. P. Murphy	W. M. Delaney	T. L. Gordy	G. H. Shattles
Indianapolis	C. M. Marlatt		G. H. Pearson	G. H. Pearson
Kansas City	R. H. Cottrell	C. L. Austin	J. D. Jenkins	C. J. Huth
Kingsport	L. Hale	T. R. Witt	H. E. Goddard	H. E. Goddard
Los Angeles	V. V. Mason	J. R. Wilcox	R. F. Connelly	R. F. Connelly
Louisville	C. A. White	R. B. Davis	J. K. Wyatt	J. K. Wyatt
Milwaukee	J. A. Gramling	M. F. Bates	R. K. Johnson	V. A. Weiss
Mohawk-Hudson	H. Apkarian	R. McBride	E. S. Preble	E. S. Preble
Montreal	R. D. Poole	J. H. Lemeilleur	K. Bloxham	J. S. Williams
New York	D. B. Gordon	H. D. Lewis	M. M. Gurgo	F. J. Stolting
N. California	R. H. Decker	A. C. West	G. H. Hommer	L. P. Richardson
Ontario	J. F. Parker	C. I. McDougall	W. H. Mann	J. Greer
Philadelphia	R. W. Clark	M. H. Keyes	F. L. Heist	N. A. Bracht
Pittsburgh	W. G. Ritter	A. D. Binz	M. Parker	O. B. Rosstead
Saginaw Valley	R. P. Schreiber	J. M. Small	W. A. Mason	W. A. Mason
St. Louis	G. W. Schall	G. W. Gergeceff	E. R. Harris	E. R. Harris
Twin Cities	D. L. Heimes	J. B. McFail	C. H. Sweet	L. N. Croteau
Wheeling	C. Billingsley	S. R. Fredlock	S. J. Litten	S. J. Litten
Youngstown	D. E. Whitehead	P. R. Cleary	W. E. McGaffney	E. M. Downs

ADDRESSES OF SECTION SECRETARIES

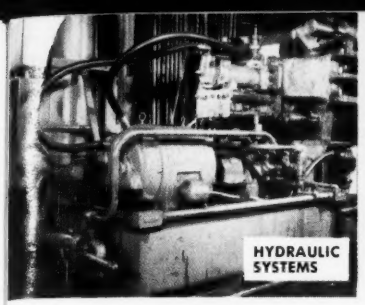
Baltimore ..... C. J. Devries, Sexton & Peake, Inc., 1025 Conn. Ave. NW, Washington 6, D.C.
Boston ..... E. G. Jackson, Summer St., Magnolia, Mass.
Buffalo ..... J. A. Eckhardt, Esso Std. Oil Co., 300 Bernhardt Dr., Snyder 21, N. Y.
Central Ohio ..... M. Ray, Marble Cliff Quarries Co., 2100 Tremont Cntr., Columbus, Ohio
Chicago ..... E. W. Drummond, Interntl. Harvester Co., 5225 S. Western Blvd., Chicago 9, Ill.
Cincinnati ..... E. L. Curtis, 3 Sylvan Lane, Cincinnati 15, Ohio
Cleveland ..... G. L. Smith, 2461 Noble Rd., Cleveland Heights 21, Ohio
Connecticut ..... L. Edwards, Gulf Oil Corp., 68 Carmel St., Hamden, Conn.
Dayton ..... H. A. Bradley, 3600 Hertland Dr., Dayton 9, Ohio
Detroit ..... C. F. Cowley, Fiske Bros. Refg. Co., 18516, J. Couzens Hwy., Detroit 35, Mich.
Duluth/Iron Range ..... C. D. Johnson, Box 834, Hoyt Lakes, Minn.
Fort Wayne ..... J. M. Olson, 4301 SE Anthony Wayne Dr., Fort Wayne, Ind.
Houston ..... T. L. Gordy, Continental Oil Co., P. O. Box 2197, Houston, Tex.
Indianapolis ..... G. H. Pearson, Jr., 6244 E. 25th St., Indianapolis, Ind.
Kansas City ..... J. D. Jenkins, Box 1099, Kansas City, Mo.
Kingsport ..... H. E. Goddard, 407 Cutler St., Greeneville, Tenn.
Los Angeles ..... R. F. Connelly, 6033 N. Camellia Ave., Temple City, Calif.
Louisville ..... J. K. Wyatt. Standard Oil Co. (Ky.), 430 W. Bloom, Louisville 8, Ky.
Milwaukee ..... R. K. Johnson, Best Engrg. Co., 1504 W. National Ave., Milwaukee 4, Wis.
Mohawk-Hudson ..... E. S. Preble, Greenbush Ave., E. Greenbush, N. Y.
Montreal ..... K. Bloxham, Can. Pratt & Whitney Aircraft Co., Longueuil, Q, Can.
New York ..... M. M. Gurgo, Esso Standard Oil Co., 151 Hamiltonian Dr., Red Bank, N. J.
N. California ..... G. H. Hommer, 1271 Mt. Diablo St., Concord, Calif.
Ontario ..... W. H. Mann, D. A. Stuart Oil Co., 3575 Danforth Ave., Toronto, Ont., Can.
Philadelphia ..... F. L. Heist, E. F. Houghton & Co., 303 W. Lehigh Ave., Phila. 33, Pa.
Pittsburgh ..... M. Parker, E. F. Houghton & Co., Bessemer Bldg., Pittsburgh 22, Pa.
Saginaw Valley ..... W. A. Mason, Shively Bros., Inc., 3606 Comanche Ave., Flint, Mich.
St. Louis ..... E. R. Harris, Alemite Co., 3227 Locust Blvd., St. Louis 3, Mo.
Twin Cities ..... C. H. Sweet, Minneapolis-Moline Co., Box 1050, Minneapolis, Minn.
Wheeling ..... S. J. Litten, Sun Oil Co., 910 Pearl, Martins Ferry, Ohio
Youngstown ..... W. E. McGaffney, 3209 Meredyth Lane, Youngstown 11, Ohio

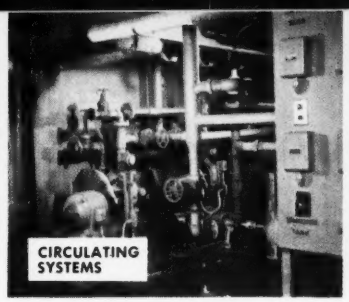
NATIONAL COMMITTEE CHAIRMEN

Abstracts ..... W. E. Campbell, Clevite Research Center
Annual Meeting (Detroit) ..... J. A. Brady, Penn-Petroleum Corp.
Annual Meeting Sites ..... J. D. Lykins, Wheeling Steel Corp.
Awards ..... J. H. Fuller, E. I. duPont deNemours & Co., Inc.
By-Laws ..... W. H. Millett, Carbide & Carbon Chemicals Co.
Editorial ..... R. K. Gould, The Texas Co.
Education ..... B. G. Rightmire, Massachusetts Institute of Technology
Exhibit Arrangements ..... M. L. Beardslee, General Motors Corp.
Finance ..... C. C. Blaisdell, Penola Oil Co.
Handbook Advisory ..... C. R. Schmitt, E. F. Houghton & Co.
Historian ..... W. G. Fatch, U. S. Steel Corp.
Journal Bearing Research ..... E. M. Kipp, Aluminum Co. of America
Lubrication Conference ..... E. E. Bisson, National Advisory Committee for Aeronautics
Membership & Admission ..... B. T. Harding, Midwest Oil Co.
Nominations ..... J. W. Hopkinson, Penn-Petroleum Corp.
Program (Annual Meeting—Detroit) ..... C. R. Lewis, Standard Oil Co. (Ind.)
Projects ..... R. A. Kraus, Republic Steel Corp.
Tellers ..... R. G. Grothus, Bell & Howell Co.

TECHNICAL COMMITTEE CHAIRMEN

Technical Advisory Board ..... S. R. Calish, Jr., California Research Corp.
Bearings & Bearing Lubrication ..... A. A. Raimondi, Westinghouse Electric Co.
Engine Lubrication ..... N. C. Penfold, Southwest Research Institute
Fluids for Metal Working ..... W. J. Wojtowicz, H. A. Montgomery Co.
Gears & Gear Lubrication ..... T. W. Havely, Shell Oil Co.
Hydraulics & Hydraulic Machinery ..... R. Q. Sharpe, Socony Mobil Oil Co., Inc.
Lubricant Reclamation & Disposal ..... A. B. Two, Ford Motor Co.
Lubrication Equipment ..... E. M. Higgins, Master Lubricants Co.
Lubrication Fundamentals ..... D. Godfrey, California Research Corp.
Lubrication Practices ..... R. J. Torrens, Eastman Kodak Co.
Properties of Lubricants ..... C. W. Nichols, Jr., Socony Mobil Oil Co., Inc.
Seals & Packings ..... R. W. Blair, Chicago Rawhide Mfg. Co.

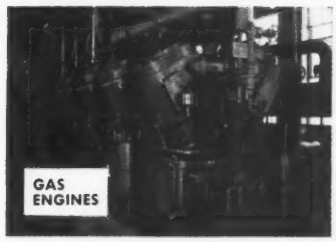


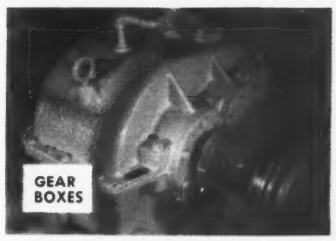


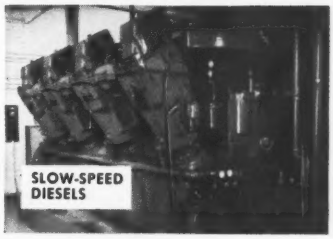
SUN SOLNUS OILS IDEAL LUBRICANTS FOR 80% OF ALL APPLICATIONS

Moderately priced...low in carbon-forming tendencies, Sun Solnus® oils simplify your storage problems by doing with *one oil* many jobs that would otherwise require *several.* Their ability to protect metal parts against corrosion, their resistance to oxidation, and their moderate price all add up to "more lubrication per dollar."

For technical information, see your Sun representative, or write to SUN OIL COMPANY, Philadelphia 3, Pa., Dept. I-51.







SUNOCO®

INDUSTRIAL PRODUCTS DEPARTMENT

SUN OIL COMPANY

PHILADELPHIA 3, PA.

© SUN OIL CO.

In Canada: SUN OIL COMPANY LIMITED, Toronto and Montreal

Valve on left is from compressor run for 3,000 hours with well-known, high-grade oil. At right is same valve after a 3,000-hour run with Sun Solnus oil. Note difference in carbon deposits.

3000-HOUR TEST PROVES SUN SOLNUS OILS REDUCE CARBON BUILD-UP IN COMPRESSORS

Equipment: A three-stage Norwalk horizontal-type compressor. Operating pressure: from 1,000 to 1,500 psi.

Test: The compressor was cleaned thoroughly and filled with a well-known, high-grade oil. The equipment was run for 3,000 hours, then torn down for inspection and cleaning. Then Solnus® 300 was tested in the same way.

Results: Look at the two pictures. You can see for yourself how Solnus oil reduced dangerous carbon build-up.

All types of reciprocating air compressors that have been changed over to a Sun Solnus oil show similar results. A test in your compressor will show the same remarkable reduction of carbon deposits.

You can get a technical bulletin about Sun Solnus oils by asking your Sun representative, or write to SUN OIL COMPANY, Philadelphia 3, Pa., Dept. I-52.

SUNOCO®

INDUSTRIAL PRODUCTS DEPARTMENT

SUN OIL COMPANY PHILADELPHIA 3, PA.

© SUN OIL CO.

IN CANADA: SUN OIL COMPANY LIMITED, TORONTO AND MONTREAL

LUBRICATION ENGINEERING

RESEARCH APPLICATION EDUCATION MAINTENANCE

Volume 13, No. 3

March, 1957

The Society and the TAB

The administrative affairs of the Society concern only a small segment of the membership, and are really only the means to an end. The purpose of ASLE is basically the advancement of the science of lubrication engineering. Who, then, puts the "LE" in ASLE? — *the TAB*!

For the past year those interested in the technical life of the Society have been operating under a reorganized committee structure. Your Organization and Operations Committee believed that the science of lubrication engineering as pursued by ASLE could best be served by granting more autonomy to, and placing more responsibility in, the groups interested in the various phases of the science, i.e., the Technical Committees.

To supervise the activities of these committees, to advise them of past experiences, and to act as go-between for them in matters requiring action of the Board of Directors, the new Technical Advisory Board was established. This board replaced the General Technical Committee structure. While broad principles of operation were laid out in the document prepared by the O&O Committee (See *"Lubrication Engineering,"* May-June 1956), detailed organization has largely been "played by ear" during the past year. It has become apparent that about as much responsibility can be assumed as can be effectively carried out, and the TAB is becoming an increasingly important group in ASLE affairs.

TAB is composed of a six-man Executive Committee elected by the Directors, plus each Chairman of a Technical or Industry Committee. The Chairman of the TAB is appointed as Vice-Chairman by the President-Elect, and automatically succeeds to the Chairmanship. Liaison with the Board of Directors is through the Vice-President-at-Large.

Each member of the Executive Committee sponsors a group of committees and is responsible for the execution of delegated tasks by each group. He is their spokesman in meetings of the TAB.

ASLE Technical Committees have existed for years. In the "tender years" of our Society, their prime responsibility was the procurement of papers and speakers for our Annual Meeting. Those of you who have been saddled with this job in local sections know how difficult it can be, and I am sure, realize that no committee can long endure with this sole function.

With the idea in mind that the Society exists to serve the membership, the O&O Committee sought to broaden the responsibility of the Technical Committees; thus to extend their appeal so that more members would participate. We are well on the way to accomplishing this objective. About 400 people are now engaged in committee activities.

The new committee structure of TAB provides for both "vertical" and "horizontal" groups. Those interested in the profession of lubrication engineering are concerned with the design of lubricated machine elements, the phenomena of lubrication, the lubricant, or the use and maintenance of lubricants. If their principle interest lies primarily in one of these phases, they should participate in a Technical Committee typified by the Bearings and Bearing Lubrication Committee or that designated Lubrication Practices. These are "vertical" groups.

On the other hand, if the practice of their profession involves a member in all of the foregoing phases, but within a single industry, one of our new Industry Committees may interest him more. The new Machine Tool Committee, or a proposed Aviation Committee, cover all phases of lubrication engineering encountered in the particular field.

Regardless of the Organization in which he elects to serve, the ASLE member will be benefitted by serving the Society. As in all things, the benefits are in direct proportion to the effort put forth. In addition to obtaining papers, committee activitities now include outlining research proposals, answering technical inquiries, abstracting articles, and writing up scientific information. Wherever your interest lies, we can use your help! Most of the committees will meet during the annual meeting in Detroit, April 15-17. Express your interest — contact any committee member for details!

S. R. Calish, Jr.

Chairman, Technical Advisory Board

"CLICK" lubrication starts when your machines start!

ALEMITE OIL-MIST AUTOMATIC LUBRICATION

provides constant, foolproof uniform lubrication— to protect *any* moving surface!

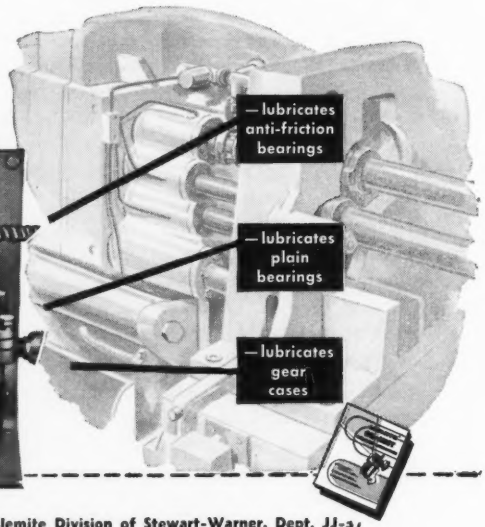
Alemite Oil-Mist lubrication can be easily designed into any new or installed machine. This simple, continuous, completely automatic system eliminates human error—multiplies bearing life—reduces product spoilage—boosts machine output! Operates on compressed air . . . starts and stops when machine switch is turned on and off. Airborne lubricant is conveyed through tubing to bearings. Mail coupon below for full details about Alemite Oil-Mist. Now in use on modern, high-speed machines.

Lubricates any bearing on any machine with one of three types of fittings:

Mist fittings for roller, ball, needle—or any anti-friction type of bearings.

Spray fittings for open and enclosed gears and chains.

Condensing fittings for plain bearings, slides, ways, vees, cams, and rollers.



8 Advantages of the Alemite Oil-Mist System

1. Continuous lubrication. Deposits fresh, clean film of oil on all surfaces of all bearings.

2. Fully automatic. Starts and stops with operation of machine switch.

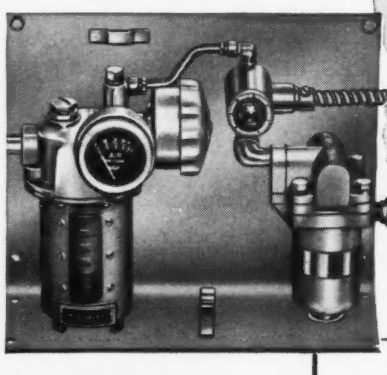
3. No guesswork. Bearings can't be overlooked, or over-lubricated!

4. Reduction of bearing temperatures. Acts as bearing coolant. Reduces bearing temperatures as much as 20°F.

5. Fewer types of oil. Reduces number of oils that must be stocked, handled and applied.

6. Elimination of downtime. All bearings are constantly lubricated while machines continue to operate.

7. Extension of bearing life. Life of grinding machine bearings have been extended from 400 to 7,000 hours!



8. As high as 90% less oil consumption. Usually consumes about 1/10th amount used by any other oiling method.

Mail coupon for Oil-Mist demonstration and information

ALEMITE
REG. U. S. PAT. OFF.

Division of STEWART-WARNER CORPORATION

STEWART SW WARNER

Alemite Division of Stewart-Warner, Dept. JJ-3,
1850 Diversey Parkway, Chicago 14, Illinois

☐ Please send me a FREE copy of your new and complete Oil-Mist catalog.

☐ Please have your Alemite Lubrication Representative arrange a no-obligation demonstration.

Name.....

Company.....

Address.....

City.....Zone.....State.....

Personals

C. M. Allen

M. Z. Fainman

C. E. Schmitz

R. Q. Sharpe

K. V. Rohlen, President of the Crane Packing Co., Morton Grove, Ill., has announced the promotion of **C. E. Schmitz** (ASLE Past President, and Chicago Section Member) to Executive Vice-President of the company. Mr. Schmitz was formerly Vice-President in Charge of Sales.

Pennsylvania Salt Mfg. Co., Philadelphia, Pa., has announced the appointment of G. R. Lawson as Director of Marketing, and the promotion of A. F. Bixby as Manager of Marketing Research, for the company's new Industrial Division.

G. E. Merkle (ASLE New York Section) has been elected President of Fiske Brothers Refining Co., Newark, N. J.

The Texas Co., New York City, has announced the election of O. J. Dorwin as a Director, and T. A. Mangelsdorf as a Vice-President of the company; and the appointment of H. W. Schilling as Assistant Manager of the company's Marine Sales Division.

R. L. Stephenson, Vice-President in Charge of Industrial Divisions of U. S. Hoffman Machinery Corp., New York City, has been appointed Director of Export & Foreign Operations in addition to his present duties.

M. Z. Fainman (ASLE Chicago Section), formerly Sr. Project Chemist for Standard Oil Co. of Ind., has been named Executive Engineer for the Cobalt 60 project of the Cook Technological Center, Morton Grove, Ill. Dr. Fainman's initial project will be a study of the effect of radiation on petroleum products.

Tuthill Pump Co., Chicago, Ill., has announced the appointment of J. W. See as Regional Sales Manager in charge of the company's sales organization in New England, New York, New Jersey, and the eastern half of Pennsylvania. He will make his headquarters at 30 Red Road, Chatham, N. J.

Baroid Div., National Lead Co., Houston, Tex., has announced the appointment of C. M. Finlayson as Manager of Bentone Sales.

C. M. Allen (ASLE Member) has been appointed Consultant in the Engineering Mechanics Div. of Battelle Memorial Institute, Columbus, Ohio. Mr. Allen, a specialist on bearing problems and the related fields of friction, lubrication, and wear phenomena, will direct his attention to the technical planning and guidance of Battelle's research programs in these fields.

The Garlock Packing Co., Palmyra, N. Y., has announced the creation of a Product Engineering Dept., under the direction of E. W. Fisher, Manager; and the appointment of A. R. Tobias, as Engineer-in-Charge of the Mechanical Test Room.

E. G. Clarke, formerly Managing Director of Acheson Colloids, Ltd., London, has been elected to the newly created post of Vice-President in Charge of European operations for Acheson Industries, Inc. Mr. Clarke will continue to make his headquarters in London at 18 Pall Mall, S.W.1.

H. A. Fohl (ASLE Philadelphia Section) has become affiliated with the Johnstone Engineering & Machine Co., Parkesburg, Pa., as a Consultant on Administration, Engineering & Fabrication.

E. W. Neben has been named Director of the recently formed Central Engineering Div. of The Pfaudler Co., Rochester, N. Y.

The Aro Equipment Corp., Bryan, Ohio, has announced the promotion of W. H. Moore to Field Service Manager of the Arolube Div.; and the appointment of J. E. Wilson, as Sales Representative for the Northern Illinois territory (excluding Cook County), and L. F. Raymond, Jr., as Sales Representative for the Cook County, Ill. and Lake County, Ind. territory (both with headquarters in Chicago).

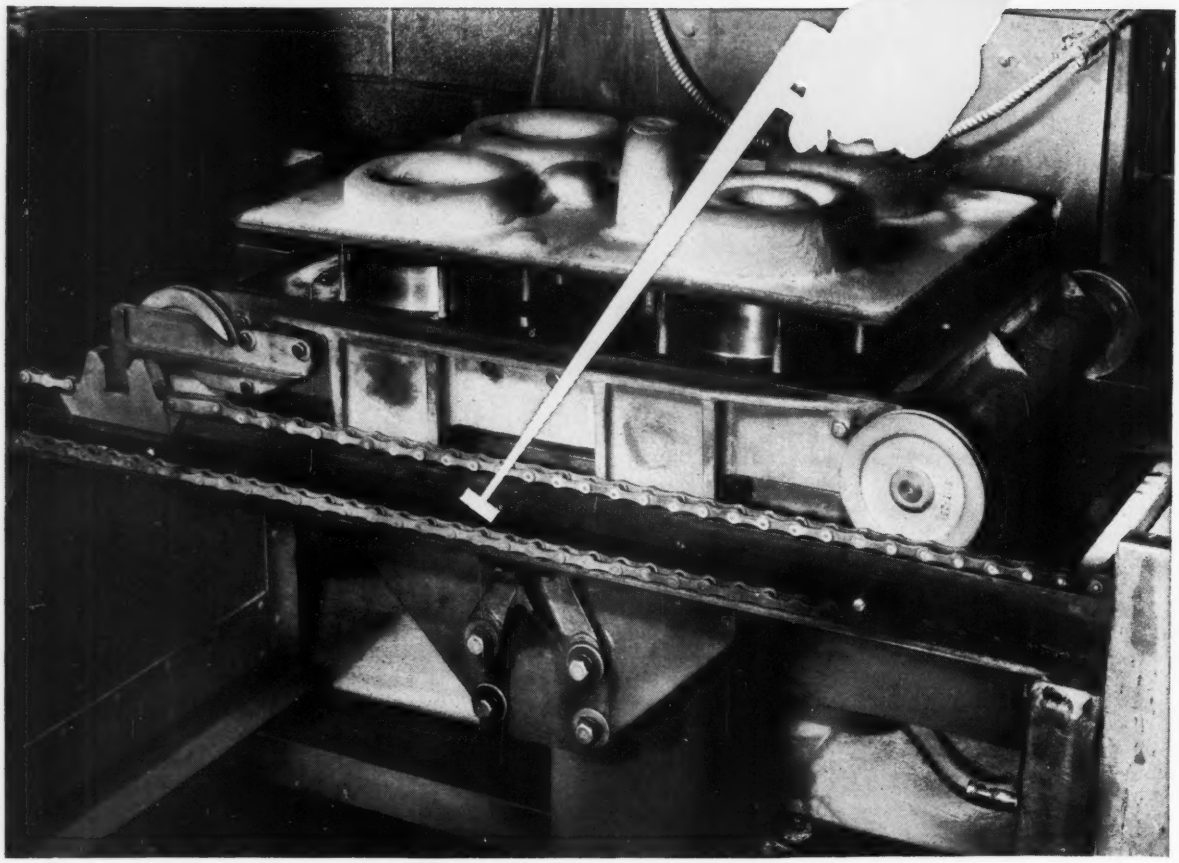
Mason-Neilan, Div. of the Worthington Corp., has announced the appointment of E. A. Bianchi, as Vice-President in Charge of Engineering; and the promotion of P. Wing, Jr., to Chief Engineer.

R. F. Connelly (ASLE Los Angeles Section) has been appointed Sales Manager of the Aircraft & Chemical Div. of the Bray Oil Co., Los Angeles, Calif.

J. L. Sheehy has been appointed District Manager (with headquarters in San Francisco) of the Western Area recently established by Tube Turns Plastic, Inc., Louisville, Ky., manufacturers of fittings, flanges, and valves of polyvinyl chloride for indus-

(Continued on p. 167)

A Touch here does so much



TORRID TRAVELERS

A touch of 'Oildag',® and shell mold pattern carriages keep shuttling smoothly at temperatures of 400°F to 900°F, every 30 seconds, 24 hours a day. Wheels turn freely, hitches drop snugly into place, and chains keep driving; shell molding machines deliver at maximum capacity without interruption.

'Oildag' and other colloidal graphite dispersions are widely used on conveyor systems for glass annealing and for paint and enamel baking ovens where things must keep moving despite high temperatures and hard, continuous service.

In the kilns where porcelain products are fired, temperatures are even higher. Ordinary lubricants burn up, but 'dag'® dispersions keep kiln car wheels turning.

Wherever mechanisms must operate in high temperatures, and ordinary lubricants can't take it, chances are good that one of the many 'dag' dispersions will solve the problem. Talk with your Acheson Service Engineer soon, and write for Bulletin 423 — High Temperature Lubrication. Address Dept. LE-3.

dag®

ACHESON COLLOIDS COMPANY

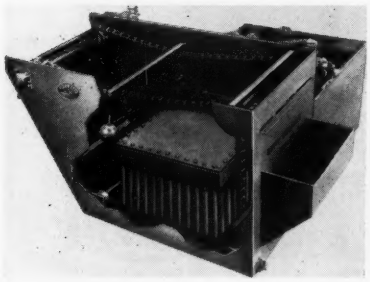
Port Huron, Michigan...also Acheson Colloids, Ltd., London, England

ACHESON COLLOIDAL DISPERSIONS:

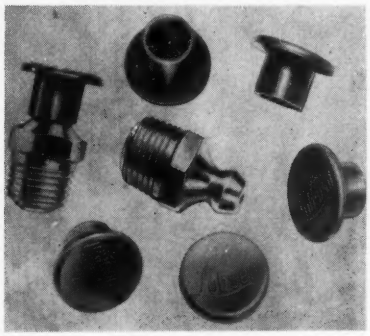
Graphite · Molybdenum Disulfide · Zinc Oxide · Mica and other solids

Offices in: Boston · Chicago · Cleveland · Dayton · Detroit · Los Angeles
Milwaukee · Philadelphia · New York · Pittsburgh · Rochester · St. Louis · Toronto

New Products



Tubular Screen-Type Filter. Designed for more efficient filtration and maximum flow capacity of coolants, cutting oils, and all liquids requiring removal of minute particles, the new Delpark Filter-Matic Filter (pictured above) proves versatile in application and economical in operation. Small diameter screen tubes are manifolded together into a common suction header through which the sludge-laden liquid is drawn by a special multiple-chamber valve and pumped into a filtered liquid compartment. As the screen deposits reduce the liquid flow through the screen tubes, the unfiltered liquid level begins to rise. At a predetermined level, a float actuates a switch controlling the multiple-chamber valve, reversing the flow of the liquid. The reversed flow backwashes accumulated deposits from the screens. As the reverse flow of clean liquid causes the unfiltered liquid to continue its rise, the float again reverses the flow of liquid through the valve, returning to the filtering cycle. Sludge removed from the screen tubes drops to the bottom of the filter compartment where it is removed by chain-driven dragout flights. When precoat is used, an automatic measuring device with a vibrating mechanism to prevent bridging of the precoat material is mounted above the filter inlet and automatically feeds a predetermined amount of precoat material at each backwash period. This precoat feeding device is actuated by the air cylinder feed which operates the multiple-chamber valve. This automatically adds new precoat at the same time the old precoat is backwashed from the tubes. (Industrial Filtration Co., Dept. FM-395, Lebanon, Ind.)



Grease Fitting Caps. A practical, economical solution to the problem of maintaining clean, dirt-free grease fittings between lubrications is available through a Tenite II Butyrate plastic cap. The product, called "Lubseals" (pictured above), may also be used to mask grease fittings during spray painting. These caps snap over any standard grease fitting to prevent harmful particles of dust, grit, and abrasives from collecting on fittings, and later being injected into bearings during greasing. Priced at $7.50 per thousand, they are available in four bright, attention-giving colors which effectively "flag" hard-to-find grease fittings, thus eliminating skips and grease-starved bearings. Distinctive colors may be used to inexpensively color-code lubrication systems on machines where some fittings require more frequent greasing. When machinery is to be spray-painted, Lubseals offer a fast, efficient method for masking grease fittings and, whether used as dirt seals or spray paint masks, may be used or re-used indefinitely. (Wilson Plastics, Inc., 1531 Milan Rd., Sandusky, Ohio.)

Plug Valve. A new plug valve that provides leakproof shut-off operated by a handle that opens and closes against pressure, features the use of three "O" rings. In the closed position, one O-ring contained on the surface of the plug (90° from the flow passage through the plug) serves as a flow seal. This flow seal O-ring surrounds the inlet port and provides dead-tight shut-off. In the open position, the valve is full-ported and allows a straight-through flow passage. Static O-rings at the top and bottom of the plug and around its circumference positively prevent stem leakage. The use of the O-rings eliminate adjusting nuts and springs and, therefore, permits the long adjustment- and maintenance-free service life of the valve. The plug valve is made of brass and is available in ¼" female pipe connections. (Circle Seal Products Co., Inc., 2181 E. Foothill Blvd., Pasadena, Calif.)

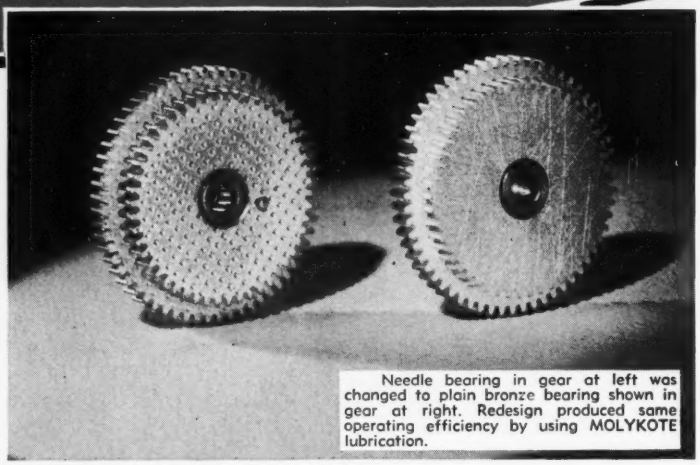
Drum Handling Equipment. A drum tilter that makes it easy for one man to empty a standard 55-gallon drum has been developed by Heppenstall. Lowered over a drum, the tilter is ready to lift it safely as soon as two load binders are tightened. When the drum is lifted to the proper position, a light pull on a chain or a turn of a handwheel is sufficient to turn the drum so that its contents can be poured or dumped. The tilter is particularly recommended for handling chemicals and solvents and will handle loads up to 750 pounds. It is suitable for both disposable-type and returnable-type 55-gallon drums. The drum can be rotated through a full 360 degrees by a worm drive arrangement. Two locking devices are provided for safety in operation. Tilters for other sizes of drums can be made to order. (Heppenstall Co., Pittsburgh 1, Pa.)

Rust-Preventive Base. A new multi-purpose rust-preventive base, identified as Rust Veto M.P., has been announced that can be mixed with water, solvent or oil, or used neat. This water-displacing rust-preventive base has an exceptionally wide range of uses for indoor protection. When mixed with water, it provides a safe, non-flammable emulsion with high stability and excellent protection value. It can be used to replace dangerous solvents or similar flammable

(Continued on p. 166)

MOLYKOTE® lubricant sparks design change

SAVES EAGLE SIGNAL CORP., MOLINE, ILL. THOUSANDS OF DOLLARS ANNUALLY



Needle bearing in gear at left was changed to plain bronze bearing shown in gear at right. Redesign produced same operating efficiency by using MOLYKOTE lubrication.

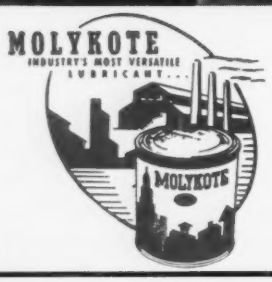
Eagle Signal Corp., Moline, Ill., manufactures the Polyflex Reset Timer, a synchronous motor driven device which trips its contacts open or closed during a time interval. The timer is a precision instrument used to control many industrial operations.

As part of the original design, a gear assembly called for a relatively expensive needle bearing. After experimenting with MOLYKOTE Lubricants, the company adopted a plain bronze bearing, lubricated with MOLYKOTE, which gave the same results as the more expensive needle bearing. The annual saving is estimated at several thousand dollars.

The application of MOLYKOTE, Type M-55, to the bronze bearing shows simplicity of operation as well as the small amount of lubricant needed.

MOLYKOTE, TYPE M-55, IDEAL FOR INSTRUMENT LUBRICATION

Type M-55 is a stable dispersion of sub-micron size molybdenum disulfide powder in a mineral oil. It is approved for mist lubricators and is ideal for instrument lubrication.



The ALPHA MOLYKOTE Corporation

Main Factories: 65 Harvard Avenue, Stamford, Conn.
71 Arnulfstrasse, Munich 19, Germany

755

ASLE News Notebook

Compiled by
R. D. McCormick

Boston Section Holds Education Course

A course in lubrication for industry is being sponsored by the Boston Section at the Massachusetts Institute of Technology for six consecutive weeks beginning February 11. Included in the course are the following topics: *Lubrication Review*, by D. G. Espey, Standard Oil Co.; *Gear Lubricants: Their Selection and Application*, by J. P. Critchlow, Gulf Oil Corp.; *Proper Maintenance of Anti-Friction Bearings*, by F. W. Wellons, SKF Industries, Inc.; *Maintenance of Hydraulic Systems*, by C. R. Schmitt, E. F. Houghton & Co.; *Modern Methods of Applying Lubricants*, by E. J. Gesdorf, The Farval Corp. and *Setting Up a Lubrication Program*, by C. Parks, The Bullard Company. Further information can be obtained by contacting Mr. G. R. Burnham, Gulf Oil Co., 116 Water Street, Beverly, Mass.

Plaques were presented to past Chairmen for service to the Twin Cities Section by D. L. Heimes (Center) current Chairman. Recipients included: (left to right) B. T. Harding, C. I. Kraus, E. H. Lindeman, and R. O. Erickson. C. B. Diefendorf, not present for the picture, also received a plaque.

Twin Cities Honors Past Chairmen

Past Chairmen of the Twin Cities Section were honored at the Section's December meeting and were presented with bronze plaques. Among those so honored were E. H. Lindeman *(1951-52)*, B. T. Harding *(1952-53* and *1953-54)*, C. B. Diefendorf *(1954-55)*, R. O. Erickson *(1955-56)* and the first Section Chairman, C. I. Kraus *(1949-50)*. Since its founding the Twin Cities Section has shown excellent growth, program activities and national participation. Currently, two of the past chairmen are serving the Society in the membership and Section coordination programs; Mr. B. T. Harding is National Membership Committee Chairman and Mr. R. O. Erickson is area representative for Minnesota, Iowa, and Western Illinois.

Those responsible for the program details of the Annual Meeting for 1957 include: (Front) S. B. Twiss, C. R. Lewis, J. A. Brady, D. W. Sawyer, and R. F. Urso. (Standing) J. W. Swain, E. S. Kelly, C. F. Cowley, W. J. Wojtowicz, R. L. Leslie, E. J. Dundon, and D. B. Hubert.

Annual Meeting Banquet Features Awards & Entertainment

Realizing the need for a "break" in the extensive flow of technical information being presented to the members, guests and their wives at the forthcoming annual meeting, a departure from the formal banquet program previously presented is being scheduled for April 16. Mr. George Spelin, as Toastmaster, has been requested to make the banquet an evening of relaxation and recognition. An outstanding dinner to the accompaniment of cabaret musicians is planned, to be followed with the award presentations and dancing. To be sure that you will have a place at the banquet be sure to pick up your banquet tickets at the time of registration. The banquet is planned on a small and intimate scale and is sure to be sold out early. (P.S. Be sure to bring your wife — She will enjoy the banquet, tours, and special features planned for the Ladies program.)

Connecticut Section Holds Practical Lubrication Course

A course in practical lubrication is being held for six weeks at Yale University, New Haven, Connecticut. The

Sherosope-T*

the **500** plus
molecular weight
sodium petroleum sulfonate

Fully Refined Maximum Rust Prevention
High Activity Uniform Quality

Now available in greater volume to compounders of rust preventives...

Tank Cars or Drums
in carload and less than carload quantities

Bulk deliveries from Gretna, La., and Trainer, Pa. Drum stocks available in principal areas. Write for technical information and samples to address below.

A greatly augmented source of sodium, calcium, barium, and ammonium sulfonates

Immediate benefit to you of Bryton's enlarged capacity is the increased availability of Sherosope-T. In addition to Sherosope-T, Bryton can promptly supply you with oil-soluble sulfonates for many other industrial uses. These are prepared as sodium, calcium, barium, and ammonium salts. Sodium sulfonates are offered to you in a wide range of molecular weights. Consequently, you are permitted much greater latitude in selection and utilization.

Whatever your particular requirements in sulfonates, it always pays to take it up with the Bryton representative.

BRYTON CHEMICAL DIVISION Suite 3108, Dept. L3
630 Fifth Avenue, New York 20, N.Y.

Specific sulfonates for industry

*Trademark

©1957, Continental Oil Company

course began on February 6 and continues through March 20. The final meeting includes a tour of the Scoville Manufacturing Co. at Waterbury, Conn., social hour, dinner, awarding certificates of completion to all students, and a technical panel discussion of rolling oils. Further details are available through Mr. H. A. Geer, Pratt & Whitney Aircraft, Metallurgical & Chemical Group, East Hartford, Conn.

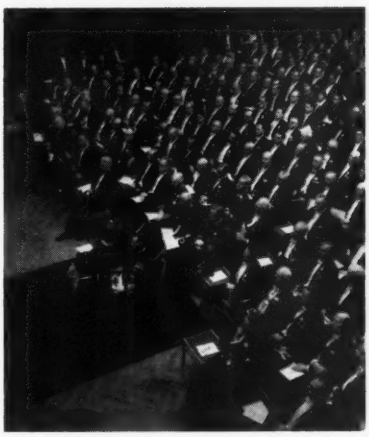
Borge Lunn Receives Hunt Medal

During the annual meeting of 1956 Mr. B. Lunn was awarded the Captain Alfred E. Hunt memorial medal for his paper *"Evaluating Bearing Materials under Boundary Lubrication."* Since he resides in Copenhagen, Denmark and could not be present to receive the award personally, arrangements were made with the Danish consulate to transport the medal to Dr. Lunn in Denmark and make the presentation honoring his work in the field of lubrication. The medal and award plaque were sent to Copenhagen, but the original award was lost in shipment when the *Andrea Doria* and the *Stockholm* collided off the Eastern coast of the United States. The award was duplicated, again sent to Dr. Lunn via the diplomatic courier, and finally arrived in December. In a recent letter from Dr. Lunn to the National Office he states ". . . The medal was handed over by the president of the Technical University, prof. dr. Engelund, with a speech about the ASLE — and once again I must express my gratitude to the ASLE for the honour. I am enclosing two pictures of the festival." We are happy to report that Dr. Lunn finally received his award in a manner befitting the significance of the Captain Alfred E. Hunt medal, and that we can now look forward to the presentation of awards for 1957 at the Annual Meeting Banquet in Detroit, April 16.

Members of the Detroit Section serving as committee chairmen for the forthcoming Annual Meeting were guests of the Board of Directors at the January Board's Luncheon. Plans were presented for the meeting, entertainment, and Ladies' Program.

Detroit Invites Pre-Annual Meeting Registrants to Champagne Party

Detroit, host Section for the 1957 Annual Meeting, is planning a champagne party to welcome members, guests and their wives to the April Annual Meeting. The party will be held at the Elk's club in Detroit at 5:30 p.m., Sunday, April 14. Mr. Morgan Lawton, Chairman of the arrangements committee for the party has invited everyone to join in the Detroit Section's hospitality on Sunday afternoon. To accommodate everyone planning to arrive at the Sheraton-Cadillac Hotel on Sunday, April 14, the registration desk will be open from 2-5 P.M. to permit members, guests, and their wives to register on Sunday and avoid the rush, and to attend the champagne party.



Annual festival of the Technical University, Copenhagen, Denmark, included King Frederik, Queen Ingrid, and a Distinguished audience representing education, commerce, and industry. Photo at left shows Dr. Lunn receiving Hunt award from Prof. dr. Engelund.

S. R. "Syd" Calish, Jr.

A recent visitor to the ASLE National Office, Syd Calish, discussed some of the activities of the Technical Advisory Board during the past year. In this month's editorial, Syd presents some of the broad aims of the Technical and Industry committees and their place in the Society organization.

Two New Sections Organizing

President E. R. Booser is attending the organization meetings to be held February 19 for Seattle, Washington and February 21, at Salt Lake City, Utah. Interest is high in these areas and it is hoped that all organization work will be completed in time for recognition of the new Sections by the April Annual Meeting. In addition, President Booser attended the February meeting of the Northern California Section to present membership certificates to the Charter members of the Section.

AUTOMATIC *Air-Borne* LUBRICATION

FOR ALL ELEMENTS OF A MACHINE

One Lubricator Per Machine — Model 33AL-4 (½") Lubrication Unit automatically creates finely divided air-borne oil fog. Completely lubricates a machine having a maximum requirement of 100 bearing inches.

Better Lubrication — Continuously applies protective film of fresh oil to lubrication points. Never periods of too much or too little lubrication.

Compact, Complete, Attractive — Measuring only 6-1/32" x 6-1/32" x 5-3/16", cabinet contains air filter, pressure regulator, MICRO-FOG Lubricator.

Visual Oil Feed — Oil feed is readily visible, providing positive proof of lubrication. No guesswork.

For complete information on MICRO-FOG Lubrication for all bearing inch requirements, call your nearby Norgren Representative listed in the telephone directory — or WRITE FOR FACTORY LITERATURE.

MICRO-FOG by Norgren

C. A. NORGREN CO.

3434 SOUTH ELATI STREET • ENGLEWOOD, COLORADO

Lube Lines

by A. F. Brewer*

COMPATIBILITY OF LUBRICANTS IN SERVICE

The dictionary refers to compatibility as the quality of being compatible, congruous, or suitable. From a lubrication point of view the idea of suitability is most applicable, as it relates to the extent to which certain lubricants of possibly varying physical characteristics can be mixed without detracting from their lubricating ability. When straight mineral oils are involved, it can be assumed that there is acceptable compatibility even though there may be a difference in base or method of refining. In other words, a relatively homogeneous mixture of good stability can be obtained. Blending of two oils of the same base but different viscosity to obtain an intermediate viscosity is possibly the simplest example of compatibility. Here the least change in other physical characteristics such as flash or pour points usually is observed.

Additive-type oils and greases, however, pose more of a problem and require more serious consideration when it may be proposed to add a different brand product as make-up to the lubricant already in service. Then it is most important to know that the respective products will mix or blend together perfectly and not be subject to adverse additive reaction, depletion, or separation. Normally this requires assurance from the manufacturers of the respective lubricants that their products are entirely compatible with each other. The customer cannot prove this to his own satisfaction because he usually does not have the necessary laboratory equipment nor the chemical know-how to develop the required information. E.P. gear oils, heavy-duty engine oils, turbine, hydraulic, and circulating oils inhibited to resist rusting, oxidation, and foaming are typical of the types of oils which must be studied for compatibility.

With regard to lubricating greases, the ASTM Committee D-2 on Petroleum Products and Lubricants recently has approved the statement prepared by its Technical Committee "G" on Lubricating Grease, to the effect that "Compatibility of lubricating greases implies compatibility in service. Owing to the complexity of service problems, there is no single test which can be used to satisfactorily evaluate compatibility in general." Certain bench tests can be made to predict to some extent what might be expected when two greases are mixed, but "tests such as these must be correlated with a particular set of service conditions before a valid estimate of compatibility in such service can be achieved."

Granting the wisdom of following these procedures, somehow it might seem to be a round-about approach to the problem. Why not consider the lubrication requirements of the machine as of primary importance? Then, with appreciation of the fact that the customer should feel that he is buying *lubrication performance* rather than lubricants, let him, so-to-speak, start from the beginning, i.e. forget about mixing lubricants and start fresh. He should realize that mixing lubricants can become a pernicious practice whenever there is temptation to regard price per pound or per gallon before quality or lubricating ability.

Accordingly, if he wants to change brands for any reason whatsoever, it would be better to drain and flush his unit to make sure it is free from the previously used lubricant and any deleterious contaminants. Then he can safely add a charge of the new oil or grease with more positive assurance that its physical and chemical characteristics, as developed by the refiner to meet the expected operating conditions, will result in most dependable performance both of the lubricant as well as the machine.

The idea may cost a little more but, usually, this will apply mostly to systems where upwards of several hundred gallons of cirulating oil are involved, i.e. in turbine, hydraulic, steel, and paper mill service. Even so, the loss usually becomes negligible because very often the drained used oil can be applied to yard equipment or other service where "once through" lubrication is practiced. In engines and in most greasing systems, regular periods for draining, flushing, and cleaning generally are followed anyhow, so to change brands here and avoid the risk of non-compatibility should involve hardly any extra cost.

*Consultant, and Author of *Basic Lubrication Practice.*

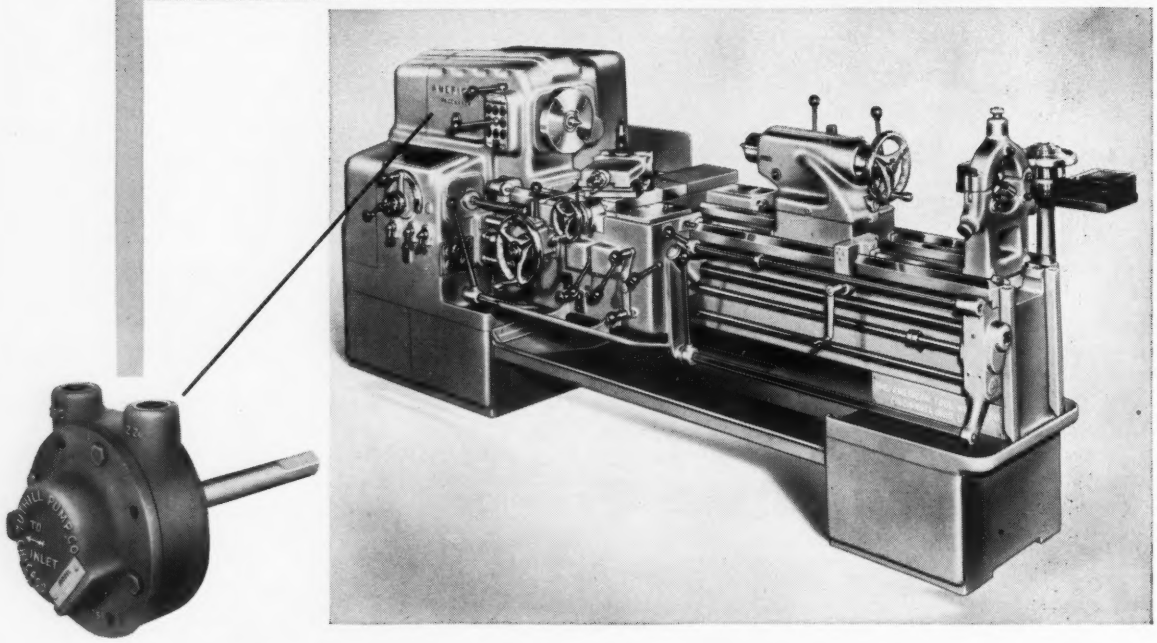
It's Detroit in '57

as the scene of the

ASLE 12th Annual Meeting & Exhibit

April 15-16-17 Sheraton-Cadillac Hotel

ANOTHER PUMP PROBLEM...SOLVED BY **TUTHILL**



Automatic Lubrication for the American "Pacemaker" with Tuthill Pumps

Among the advantages of American Tool Co.'s new "Pacemaker" lathes is a complete pressure lubrication system to the entire headstock mechanism. Filtered oil is forced directly to all bearings, including spindle bearings, and is sprayed onto the transmission gears. The pressure system also lubricates the entire starting clutch and brake mechanism. The oil reservoir is located below the gear line to prevent churning of the oil by the gears when revolving at high speeds.

The important problem of the right pump for the lubrication system was an easy one for American's engineers. Like other leading machine tool builders, they found the answer at TUTHILL—an organization with long experience in meeting the specialized lubrication requirements of the machine tool, refrigeration, Diesel, and other industries.

The pump which provided the answer to American's problem was a modification of Tuthill's RCS—one of the more than 750 models in the Tuthill line. The RCS adds to the advantages of Tuthill's positive displacement internal-gear design a special automatic reversing feature which permits the pump to deliver from the same port regardless of the direction of shaft rotation.

The RCS is a stripped model, supplied without mounting bracket, for incorporation directly into the designs of equipment manufacturers. Other stripped models can be supplied without housings for the same purpose.

Whatever your pump problem, your Tuthill representative probably has the answer. If a standard model does not exactly meet your requirements, Tuthill's engineers will work with you in developing a special modification for your application.

TUTHILL PUMP COMPANY
971 East 95th Street, Chicago 19, Illinois
Gentlemen:
☐ Please send information on Model RCS
☐ Please send information on complete Tuthill line.

NAME_____ TITLE_____

COMPANY_____

STREET_____

CITY_____ STATE_____

Tuthill Manufactures a Complete Line of Positive Displacement Rotary Pumps in Capacities from 1 to 200 GPM, for Pressures to 600 PSI, Speeds to 3600 RPM

TUTHILL PUMP COMPANY

971 East 95th Street, Chicago 19, Illinois
Canadian Affiliate:
Ingersoll Machine & Tool Company, Ltd., Ingersoll, Ontario, Canada

PUMPS FOR YOUR PURPOSE

The Prevention of Cutting Oil Dermatoses

D. J. Birmingham, M.D.
Occupational Health Program
Public Health Service
U. S. Dept. of Health, Education & Welfare
1014 Broadway
Cincinnati 2, Ohio

Cutting oil dermatitis is a common occupational disease; it is also preventable. But before it can be prevented, the worker, his clothing, his machine, and the oil with which he works must be clean. There are two positive approaches in preventing cutting oil dermatitis: environmental control through engineering methods, and medical control including personal hygiene.

Modern industry has recognized the importance of industrial hygiene engineering in providing a safe environment by employing closed processes and mechanical methods which minimize the contact of workers with harmful agents. Closed systems are particularly good in processing irritant chemicals, but certain mechanical devices are not always adaptable to these techniques. Efficient collecting systems may be used to control the spread of irritant dusts, vapors, fumes, and mists, keeping floors, ceilings, walls, and windows clean, and protecting the worker's health. In a large machine shop, such control methods are not always possible or practicable. Still, the industrial hygiene engineer has the responsibility to institute environmental control techniques wherever they can be used to control occupational hazards.

Preventive techniques relating to personal hygiene are the responsibility of medical and safety personnel. An effective industrial medical program assumes the following responsibilities in initiating and maintaining effective medical service in industry:

A. EDUCATION:

Any program of industrial hygiene is only as good as the ability of those in charge to recognize and control existing hazards. Before any educational program can begin, a plant must be surveyed so that medical, industrial hygiene, and safety personnel understand the hazards that must be controlled, and any hazardous processes or operations which may be eliminated. After this has been done, superintendents, foremen, and new and old workmen can be thoroughly instructed about the hazards to which they are exposed and how they can avoid injury from them.

B. MEDICAL SUPERVISION:

Second in importance is a thorough pre-placement physical examination, so that a job assignment is made within the limits of a worker's capabilities. An appraisal of a worker's health is an asset both to the plant and to the worker himself. An ideal program would include annual or, if necessary, more frequent periodic examinations. Such medical supervision often pays dividends in a reduced accident and absenteeism rate.

In judging a worker's capabilities in relation to physical examination, skin abnormalities must be considered as a part of the problem of proper placement. The satisfactory prevention of occupational dermatitis requires that the medical department know if a worker is especially susceptible to dermatitis from work-room exposure. For instance, young workers with severe acne may develop an intensification of their disease when exposed to cutting oils, tars, pitches, and solid chlorinated hydrocarbons. Preplacement and periodic examinations can avoid misplacement.

C. PERSONAL HYGIENE:

Cleanliness is the keystone in a program to prevent occupational skin disease. Ventilating systems and good maintenance are important in keeping the general environment clean, but there is no substitute for personal cleanliness, washing the hands, wearing clean clothes, and keeping clean.

A program of personal cleanliness, to be effective, requires cooperation of the industrial hygienist, the medical and safety officials, and the worker himself. Washing facilities and proper skin cleansing materials are prerequisites, but the facilities must be adequate for the work-force, well designed for use, and conveniently located. A wash basin placed at a great distance from a machine or work operation will be used infrequently.

The cleaning materials must be adapted to the type of work being done. In some instances, ordinary soap and wash basins will suffice; in others, special soaps and showers may not only be necessary, but compulsory.

Personal cleanliness at the plant begins when a man comes to work. He should use the washing facilities at least three times during the day, before lunch, after lunch, and before going home. For most workmen, this routine is sufficient; but certain jobs and certain work habits may require more frequent and more complete washing.

Industrial hand cleaners include a large variety of soap and related compounds. These include plain powders, abrasive powders, abrasive cakes, liquids, and the so-called waterless cleaners. Several good industrial cleaners now on the market are considered safe, but when abrasive agents, sand, pumice, or powdered wood chips are added to them, their mildness becomes questionable. Certain workmen cannot tolerate harsh and abrasive cleaners; a liquid, sulfonated-oil type may be preferable for them.

Waterless cleaners are numerous and are gaining in

This paper was presented at the ASLE 10th Annual Meeting, Chicago, April 13, 1955.

popularity. They clean either by their hydrocarbon solvent content, by their alkali content, or by a system of wetting agent. A study of the effects of waterless cleaners upon the skin shows that some can be definitely more irritating than the average industrial soap. This is not true of all waterless cleaners, but more information must become available before there is universal acceptance of these agents.

Mild industrial skin cleaners will generally remove ordinary industrial soils including cutting oils. Trouble arises when workers try to remove soil with solvents, which may cause skin eruptions. Solvents should not be used indiscriminately for cleaning the skin.

Most industrial skin cleaners are believed to act upon the skin in the following manner: they wet the skin and remove the soil; emulsify and remove natural oils; neutralize the pH of the skin; and disturb the horny portion of the skin by softening and removing its surface layer.

These actions upon the skin are not ordinarily harmful, but when they are reinforced by harsh soaps of the alkaline type, dermatitis of the hands and forearms may result.

To be sure, as far as possible, that proper cleaning agents are used, the medical or safety director of a plant should be familiar with appropriate cleaners. In general, the engineer or doctor will be guided by the following conditions. The cleaner should be:

1. Freely soluble in hard, soft, cold, or hot water.
2. Able to remove soil from the skin without removing too much natural skin oil.
3. Not harmful to the skin when used with moderation.
4. Agreeable to use.
5. Free from harsh abrasives.
6. Not highly alkaline (not above 10.5 pH).
7. Easy to use in cake, liquid, or powdered form.
8. Not of a type that deteriorates, becomes insect infested, clogs or corrodes plumbing.

Management can help to eliminate skin disease by providing workers with good cleaning agents, good washing facilities, and individual towels (paper or fabric). If fabric towels are used, laundered ones should be furnished frequently. Paper towels are more practical because of their ready absorbability and their ease in being discarded after use. In large plants, it is frequently more simple to establish a full system of environmental control and personal hygiene to protect individual workers. But no plant, large or small, should have to neglect personal hygiene. If workmen are expected to furnish their own soap and towels, it is doubtful if a good personal hygiene system can be established. When workers wash properly, remove industrial soil from their skin, wear clean clothing, and understand the relationship between personal hygiene and health, one of the most important factors of occupational dermatitis is controlled.

D. PROTECTIVE CLOTHING:

In some operations, no matter how careful the individual workman is, he is bound to get his clothes soiled many times a day. Oil-soaked shirts, trousers, or shoes will cause dermatitis. In the past, the wearing of oil-soaked clothing by machinists was common, since their only protection was a burlap sack which served as an apron. Usually, the clothing was washed as little as once a month.

It is no wonder, then, that cutting oil dermatitis is widespread under these conditions. In an ideal machine shop, such conditions are encountered very infrequently. Gloves, sleeves, aprons, and coveralls, impervious to cutting oils, are available to keep the worker clean. In some plants, this protective clothing is furnished by management; in others, the worker buys his own.

Where management provides protective clothing, there is better control over the wearing of the clothing, and consequently over industrial dermatitis.

Experience has proved that protective clothing such as gloves and sleeves can be the answer in protecting the workmen from being drenched with cutting oils. However, in certain operations, a glove or a sleeve may constitute a safety hazard when it must be worn near moving machinery. In such cases, shields and similar devices should be used to control the splashing of oils, and to keep the worker protected.

Even though protective devices are used, education in their proper function is necessary. They must be suited to the required job. Cotton fabrics, unless properly treated, will become oil-soaked, and oil-soaked clothing is worse than no protective clothing at all.

In conclusion, it must be emphasized that cleanliness of skin and clothing is the prime requisite in preventing cutting oil dermatitis. An educational campaign is necessary to emphasize the importance of cleanliness; proper cleansing agents and washing facilities must be provided, and these must be supported by protective clothing where necessary. Individual situations must be studied to provide protection where protective clothing cannot be worn. Establishment of a working program of personal hygiene demands enthusiasm and vigilance by supervisors, foremen, and workmen, if it is to play its part in the control and prevention of occupational dermatitis.

BIBLIOGRAPHY

1. Schwartz, L., L. Tulipan & S. M. Peck, *Occupational Diseases of the Skin*, Lea & Febiger, Inc., Philadelphia, 1947.
2. Schwartz, L., "Dermatitis from Cutting Oils," Public Health Reports, *Vol. 56*, October 3, 1941, pp. 1947-1953.
3. Schwartz, L., "Protective Ointments & Industrial Cleansers," *The Medical Clinics of North America*, W. B. Saunders, Philadelphia, July 1942.
4. Schwartz, L. & S. M. Peck, "Occupational Acne," *New York State J. of Med., Vol. 43*, September 15, 1943, p. 1711.
5. Peck, S. M., "Dermatitis from Cutting Oils, Solvents & Dielectrics Including Chloracne," *J.A.M.A., Vol. 125*, May 20, 1944, pp. 190-196.
6. Schwartz, L. & D. J. Birmingham, "Skin Cleansers for Industry," *Safety Engineering, Vol. 97*, May 1949, pp. 62-64.
7. Birmingham, D. J. & P. C. Campbell, Jr., "Prevention of Occupational Dermatitis," *Modern Sanitation, Vol. 1*, August 1949, pp. 25-26.
8. Birmingham, D. J., "Recent Advances in the Prevention of Occupational Skin Diseases," *Indust. Hyg. Quarterly, Vol. 14*, December 1953, pp. 286-288.
9. Advisory Committee on Occupational Dermatoses to the Council on Industrial Health, American Medical Association, "Dermatoses Due to Oils Used in Industry," *J.A.M.A., Vol. 157*, April 30, 1955, pp. 1611-1613.

It's DETROIT in '57 for the **ASLE 12th Annual Meeting!**

Surface Viscosity & Elasticity of Lubricating Oils

Some additives alter the surface viscosity and elasticity of a film of lubricating oil. These surface properties are readily measured at oil-air and oil-water interfaces with a torsion pendulum surface viscometer. Viscosity and elasticity data at oil-air and oil-water interfaces are summarized. New data are presented for sorbitan sesquioleate at several oil-water interfaces. A discussion is given of the significance of surface viscosity and elasticity in foaming, in emulsion stability, and in boundary lubrication.

D. W. Criddle
California Research Corp.
576 Standard Ave.
Richmond, California

INTRODUCTION

Surface properties are important in studies of foaming, emulsification, and boundary lubrication. Oil-air and oil-water interfacial tensions and adsorption phenomena have long been recognized as important surface properties. Studies of these phenomena have contributed to our knowledge of the control of the properties of lubricants by the use of additives. Recently, the viscosity and elasticity of oil surfaces have been explored and the flow aspects of some surface films of additives discussed.[1] In this paper some of the surface viscosity studies of oils found in the literature are reviewed. New data obtained with a torsion pendulum surface viscometer are presented on a typical additive at oil-water interfaces. Surface viscosity and elasticity are discussed in relation to the performance of a lubricating oil.

To avoid confusion in terminology, this paper will specify each interface as an oil-air, oil-water, oil-metal, or water-air interface. "Surface" will be used as a general term for all of these interfaces.

Surface viscosity is that viscosity at the interface which cannot be attributed to the bulk properties of two immiscible phases in contact. It is measured by the resistance to shear in the plane of the interface.[1] For example, measurements show the viscosity effects at an air-water interface are as expected from the bulk viscosity of water and air. The addition of stearic acid to the water only slightly increases the bulk viscosity of the solution, but it makes the air-water interface highly viscous. The increased resistance to shear due to such an adsorbed film depends upon molecular structure and concentration of surfactant, temperature, and the bulk materials.

For the purpose of this paper, a surface will be called elastic if, at constant surface area, deformation acting in the plane of the surface is resisted and if the surface recovers its natural shape when the deforming forces acting in the plane are removed. An elastic surface acts as if it were a rubber membrane. Elasticity has been observed at both oil-air and oil-water interfaces when certain additives are in the oil. Elastic properties are reported for proteins and for lubricating oil additives at oil-water interfaces.[1, 2]

Sherman[3] reported that sorbitan sesquioleate imparted viscosity to an oil-water interface. This viscosity was reported to pass through a maximum as the interface aged. Recent work suggested that sorbitan sesquioleate forms an elastic as well as a viscous film. Hence, sorbitan sesquioleate was chosen for this study of surface viscosity and elasticity in different mineral oils.

The general concept of oriented packing of adsorbed oil additives on a solid surface is illustrated in Figure 1. This paper will show that additives similarly adsorbed at oil-air and oil-water interfaces produce viscous and elastic films which are expected to be significant in emulsion stability and in foaming. It is suggested that the viscosity which a solid induces in a liquid is significant in boundary and mixed-friction conditions of lubrication.

MEASUREMENT OF SURFACE RHEOLOGICAL PROPERTIES

The surface viscosity of surfactant films on water has been measured using canal, rotational torsion, and pendulum torsion viscometers.[4] The last type was used in this study because it permitted a rapid investigation of the viscosity-shear rate characteristics of interfaces. At the same time, the elasticity and the variation of viscosity with working could be studied.

The torsion pendulum surface viscometer used in this study is shown in Figure 2. For oil-air interfaces, the liquid to be studied is poured into a 24-cm. diameter container. The container is raised until the pendulum disk is at the surface of the liquid. For oil-water interfaces, water is put into the container and the container raised until the surface of the liquid is level with the pendulum disk. Oil is slowly poured onto the water surface to a depth of 2.5 cm. The pendulum disk then is made to oscillate at the interface. Measurements are made of the period of the pendulum and the damping effects. The diameter and moment of inertia of the disk, the container size, and the torsion constant of the viscometer are varied to give the desired range and sensitivity. For oil systems, a pendulum with a period in air of about 30 seconds and a polar moment of inertia of 3000 g.cm.^{2} has the desired sensitivity and range. A convenient torsion

D. W. Criddle

This paper was presented at the ASLE Annual Meeting, Pittsburgh, April 4, 1956.

wire is a 0.15-mm. diameter steel piano wire which is 33 cm. in length.

The viscosity of many aged surface films varies with the amount of working and the shear rate. A range of working and shear rates is used in viscosity determinations with a torsion pendulum surface viscometer. Hence, the viscosity values in this paper will be reported as "apparent" instead of "absolute." The apparent surface viscosity is calculated from the following equation derived from Equations 2, 3, and 4 of Reference 1:

$$\sigma = \eta_o \left[\left(\frac{\Delta}{\Delta_o} \Big/ \frac{P}{P_o} \right) - 1 \right]$$

where σ is apparent surface viscosity in centipoises,

η_o is the sum of the bulk viscosities in centipoises of the two phases forming the interface,

Δ is the difference in the logarithm of the amplitude of sucessive swings for the interface with adsorbed surfactant,

Δ_o is the difference in the logarithm of the amplitude of successive swings for the interface without surfactant,

P is the period of the pendulum for the film-covered interface,

P_o is the period of the pendulum for the interface without surfactant.

Surface films often change viscosity when they are sheared. If, for example, an interface is worked by ten forced oscillations of 60° amplitude, the viscosity is frequently decreased by 50% to 90%, and the elasticity is likewise reduced. Because of this instability, the surface viscosity and elasticity of the films were studied with minimum deformation and working.

Within the author's knowledge, there is no method reported for evaluating surface elasticity in absolute units. Therefore, this paper will report surface elasticity as the change in the period of pendulum due to the restoring force of the elastic surface film.

Experimental Data

Surface viscosity and elasticity were investigated at 24 ± 1° C. for additives in petroleum fractions ranging in bulk viscosity from 0.4 centipoise to 151 centipoises. These fluids were n-heptane and three lubricating oils of low, medium, and high viscosity. Experiments showed that there are no viscosity or elasticity effects at the interfaces of these

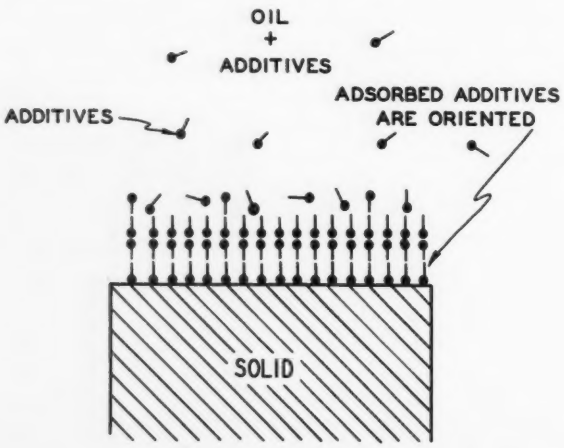


Figure 1. Additive adsorption on a surface.

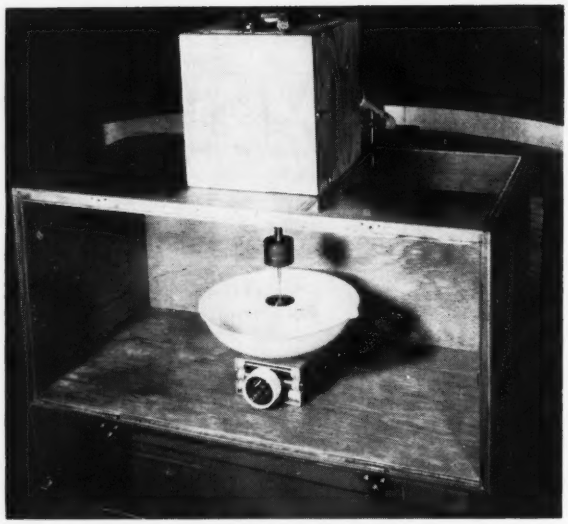


Figure 2. Torsion pendulum surface viscometer.

fluids with air or water. However, these properties were observed when certain chemicals were added to the oils at 1% to 5% concentration. Table I summarizes bulk and surface properties of these petroleum fractions and some oil-additive blends. A 5.08-cm. disk and a 24-cm. diameter container were used. Surface viscosity and elasticity data were obtained with a viscometer torsion constant of 134 g. cm.^{2}/sec.^{2}, except for the data in Figure 3 where the torsion constant was 2030 g. cm.^{2}/sec.^{2}

Some surfactants in oil lower the oil-water, but not the oil-air, interfacial viscosity and elasticity. Commercial sorbitan sesquioleate is of this type. Figure 3 shows the change in apparent interfacial viscosity with shear rate (amplitude of oscillation) at film ages of 20, 40, and 130 minutes. The apparent viscosity of these systems also depends upon the oil, the concentration of additive, and the age of the interface, as shown in Figures 4 and 5.

The elasticity imparted by sorbitan sesquioleate to an oil-water interface was measured by the decrease in the period of the pendulum. The elastic nature of this film depends upon the age of the interface, the mineral oil used, and the concentration of additive, as shown in Figure 5. Figure 6 shows that the oil-water interfacial elasticity of sorbitan sesquioleate depends upon the amplitude of oscillation.

The viscous and elastic properties reported above for sorbitan sesquioleate are believed to be due to a thin layer of emulsion at the oil-water interface rather than to a single monomolecular layer. An emulsion forms spontaneously within a few minutes after the interface is formed, and the emulsion layer increases to an estimated 0.1 mm. thickness in 24 hours. The bulk viscosity was studied for an emulsion of 50% water, 20% sorbitan sesquioleate, and 30% medium viscosity oil. For this experiment the disk was submerged one inch in the emulsion. The bulk viscosity was found to be beyond the range of the equipment. High elasticity of this bulk emulsion was evidenced by the period of the pendulum, decreasing from 7.66 seconds in air to 0.5 second in the emulsion. However, there was no detectable surface viscosity or elasticity when a water surface was covered with only a monomolecular layer of this same additive. These experiments are interpreted to mean

that the viscosity and elasticity of this oil-water interface are actually the properties of a thin layer of emulsion at that interface.

The oil used to dissolve the additive affects the magnitude and the rate of development of interfacial viscosity and elasticity (Figure 5). Variations in the viscosity and solvent power of the oil probably are responsible for the differences observed. This work shows the importance of specifying the oil used in surface viscosity and elasticity studies.

High oil-air interfacial viscosity and elasticity were previously observed when sulfurized calcium alkyl phenate was added to mineral oil.[1] The apparent viscosity of this blend is shown in Figure 7 as a function of the age of the surface and amplitude of oscillation. After this oil-air film aged, the rate of shear and the time of rest after shear both affected the apparent interfacial viscosity. Oil-water interfacial viscosity of this blend was also high, but no interfacial elasticity could be detected.

Combinations of chemicals in oil can interact to give noncumulative results.[1] For example, at 0.01% concentration in oil, commercial dimethyl silicone fluid (DC 200) imparted no viscosity or elasticity to an oil-air interface. However, when this much dimethyl silicone was added to the above blend of oil and sulfurized calcium alkyl phenate, the oil-air interfacial viscosity and elasticity were eliminated. The rate at which viscosity developed at the oil-water interface was also decreased.

The magnitude of surface viscosity and elasticity effects in lubricants is now established for several oil-air and oil-water systems. The significance of surface viscosity and elasticity is discussed below in relation to foaming, oil-water emulsion stability, and boundary lubrication.

SIGNIFICANCE OF SURFACE VISCOSITY & ELASTICITY

Foaming

Foaming in aqueous systems is caused by a combination of factors, including surface tension, surfactant concentration and adsorption rates, bulk viscosity, and surface viscosity. The surface viscosity of the oil-phenate system discussed above was eliminated by dimethyl silicone fluid, which is a well known defoaming agent for hydrocarbons. These experiments in oils are consistent with current thought that surface viscosity is a factor in foaming.

The factors responsible for a stable foam operate within

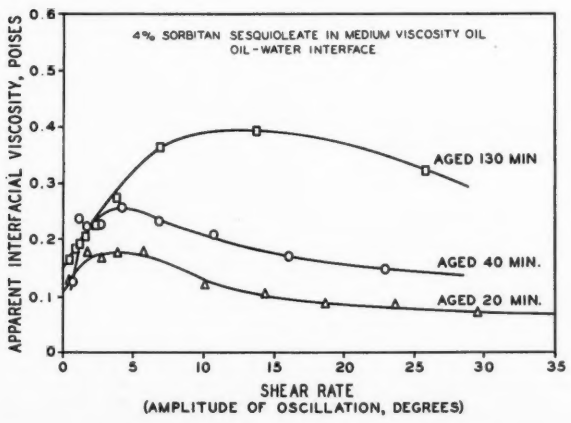


Figure 3. Effect of shear rate on apparent interfacial viscosity.

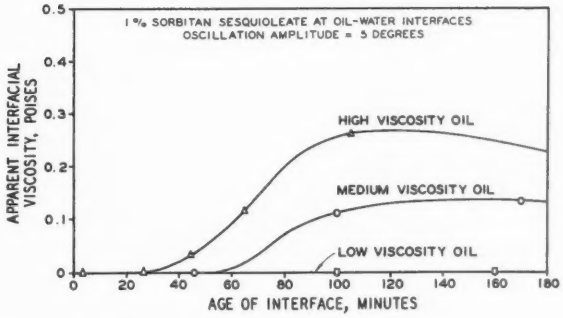


Figure 4. Effect of age on apparent interfacial viscosity.

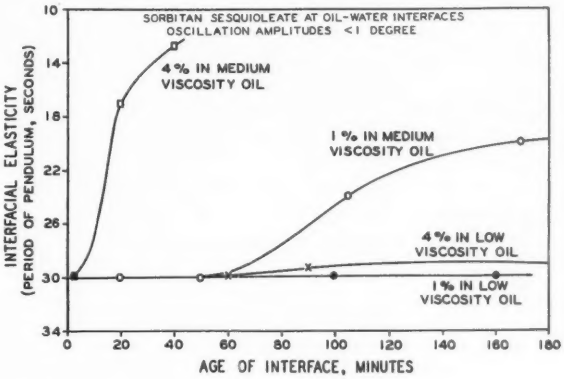


Figure 5. Effect of age on interfacial elasticity.

a fraction of a second from the time an interface is formed. The large oil-air viscosity effects shown above develop slowly and require several hours to reach maximum intensity. This suggests that even small effects of surface viscosity may be important in forming stable foam in oils.

Emulsion Stability

Oil-water emulsion stability is affected by the viscosity and probably by the elasticity of the interface. Many water-in-oil emulsions have long been known to have viscous interfacial films.[5] The bulk viscosity of some emulsions is explained in terms of the high oil-water interfacial viscosity. Sherman[6] showed that several emulsifying agents form viscous oil-water interfacial films.

The role of oil-water interfacial elasticity in emulsion stability is unknown. It is suspected that emulsion droplets which are suspended are more stable if they can withstand elastic deformations without rupture, but additional work is required to establish the significance of surface elasticity.

Lubrication

The significance of surface viscosity in lubrication is suggested by the author, although this significance has not been demonstrated. Metals probably induce increased viscosity in adjacent liquid lubricants. It is suggested that this oil-metal interfacial viscosity is desirable in boundary and mixed-friction conditions of lubrication. The reasons for these concepts are presented below.

Both theory and analogy with oil-water systems suggest that some oil-metal interfaces possess viscosity. Newtonian viscosity theory assumes an immobile adsorbed layer on a solid surface.[7] This is equivalent to assuming a surface layer of high viscosity. Metals and metal oxides are

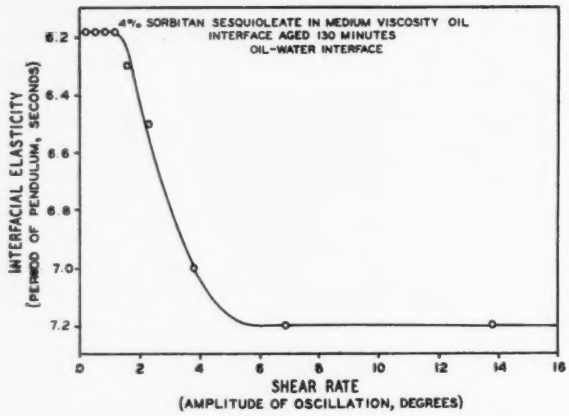


Figure 6. Variation of interfacial elasticity with shear rate.

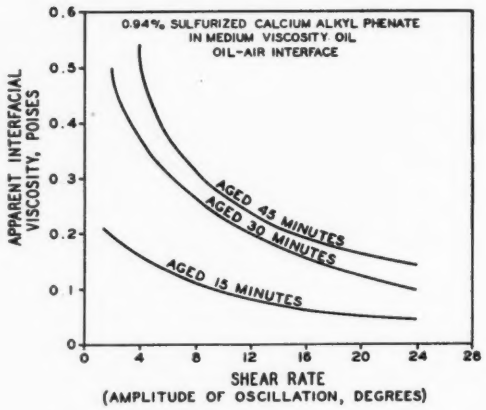


Figure 7. Effect of shear rate on apparent interfacial viscosity.

solids with high surface energy. Their strong polarizing and orienting forces are evidenced by their strong adsorption properties for polar molecules. These same forces could produce viscous, adsorbed films due to the oriented packing illustrated in Figure 1.

Large surface viscosity effects occur with surfactants at oil-water interfaces, and by analogy, these effects are expected in oil-metal systems. Part of the rigidity of an adsorbed surfactant at an oil-water interface is due to the bonding of the surfactant with water. On metal oxides and surfaces with adsorbed water, similar bonding can occur. Both the strong adsorption forces on metal surfaces and the possibility of surface bonding suggest viscous films at oil-metal interfaces.

There is some experimental evidence of interfacial viscosity at a fluid-solid interface. Although torsion pendulum surface viscometers cannot be used to obtain this information, the high viscosity effects claimed for fine capillaries[8] and the slow spreading rates of thin films[9] have been used to show surface viscosity effects at liquid-solid interfaces. Some investigators have claimed that long range surface forces from a solid cause large surface viscosity effects in an adjacent liquid, but much of the experimental basis for this concept appears to be in error.[10] It is generally agreed that the first layer of liquid in contact with a solid is immobile or has a high viscosity. The thicker and more viscous an adsorbed layer is, the more likely it is to be significant in lubrication.

Table I
Properties of Oils & Oil-Additive Blends

Composition			Properties of Blends			Surface Rheological Properties			
	Additive Conc.	Oil	Viscosity at 24° C,	Interfacial Tension at 24° C, dynes/cm		Oil-Water		Oil-Air	
Additive	Wt. %	Viscosity	Centipoises	Oil-Air	Oil-Water	Viscosity	Elasticity	Viscosity	Elasticity
None	0	n-heptane[1]	0.4	-	-	None	None	None	None
None	0	Low[2]	8 1	31	42	None	None	None	None
None	0	Medium[3]	54	32	42	None	None	None	None
None	0	High[4]	151	32	56	None	None	None	None
Sorbitan Sesquioleate[5]	1.00	Low	11	31	-	None	None	None	None
Sorbitan Sesquioleate	1.00	Medium	54	32	-	Low	Low	None	None
Sorbitan Sesquioleate	1.00	High	151	32	5	High	Low	None	None
Sorbitan Sesquioleate	4.00	Low	12	31	-	Trace	Trace	None	None
Sorbitan Sesquioleate	4.00	Medium	54	32	-	High	High	None	None
Sorbitan Monooleate[6]	3.00	Medium	54	32	2.5	High	High	None	None
Calcium Sulfonate[7]	2.27	Medium	54	32	15	None	None	None	None
Calcium Phenate[8]	0.94	Medium	54	32	23	High	None	High	High
Dimethyl Silicone[9]	0.01	Medium	54	-	-	None	None	None	None
Calcium Phenate[8] plus Dimethyl Silicone[9]	0 94 / 0.01	Medium	54	-	-	None	None	None	None

1 Viscosity = 0.41 centipoise at 24° C
2 Low viscosity oil. At 20° C density = 0.855 g/cm^3 and refractive index = 1.4778
3 Medium viscosity oil. At 20° C density = 0 872 g/cm^3 and refractive index = 1.4805
4 High viscosity oil. At 20° C density = 0.889 g/cm^3 and refractive index = 1.4844
5 Commercial sorbitan sesquioleate, Arlacel C of Atlas Powder Company
6 Commercial sorbitan monooleate, Span 80 of Atlas Powder Company
7 Neutral calcium petroleum sulfonate, 1.67% calcium, MW about 1000
8 Sulfuriced calcium alkyl phenate, 6.6% sulfur, 4 5% calcium
9 Silicone Fluid, DC-200 (350 cs at 25° C) of Dow Corning

Effective lubricant films resist penetration by the asperities of sliding solids. Adsorbed surfactants are oriented, and hence their resistance to penetration or shear depends upon the direction of the stress. Films can be sheared either parallel or normal to the plane of the surface, and the resulting components of shear are defined as "normal" and "lateral" shear. Lateral shear resistance would be more important at high than at low sliding velocity.

The surface viscosity of an adsorbed film is a measure of its lateral shear resistance, which is not the same as the bulk shear strength of solid lubricants. This discussion is concerned with the increased viscosity of a film caused by a nearby surface. The bulk shear strength of solid materials has long been known to be important in boundary lubrication.[11] It is suggested that the surface viscosity of adsorbed surface films is important.

A lubricant with low bulk viscosity, but high oil-metal interfacial viscosity, should improve lubrication under mixed-friction conditions with minimum heating and viscous drag. Under boundary conditions, a viscous, adsorbed layer of lubricant should assist any protective oxide or chemical reaction product on a surface in reducing friction. The presence of a highly viscous film of adsorbed lubricant would tend to change boundary lubrication into mixed-friction conditions, and conditions of mixed-friction would be changed toward a more hydrodynamic type. Thus, theory suggests the desirability of a lubricant with a high oil-metal interfacial viscosity.

If oil-metal interfacial viscosity is important in boundary lubrication, friction reducing additives can be expected to impart viscosity to an oil-metal interface. Long chain fatty acids, soaps, and alcohols are good boundary lubricants.[12, 13] Similar chemicals are known to induce viscosity at air-water interfaces,[14] but data are not available on their viscosity at oil-metal interfaces.

The elasticity of a boundary lubricant film may also be significant in lubrication. At oil-water interfaces, some viscous films are readily ruptured when they are sheared because they have no elasticity. Theoretically, it is desirable to have boundary lubricating films which are highly viscous and which can by their elasticity resist deformation and then recover. Data are not available to permit evaluating the significance of the elasticity of oil-steel interfaces.

CONCLUSION

The viscosity and elasticity of oil-air and oil-water interfaces have been studied with a torsion pendulum surface viscometer, and it was found that:

(1) Oil-air and oil-water interfaces are neither viscous nor elastic.

(2) Certain additives in oil at 1% to 5% concentration impart viscosity and elasticity to oil-air and oil-water interfaces.

(3) The viscosity and elasticity of oil-air and oil-water interfaces depend upon the nature and concentration of surfactant, the oil, the age of the interface, and the amplitude of oscillation.

The surface viscosity of an oil is believed to be significant in foaming and in emulsion stability. Oil-metal interfacial viscosity is expected to be important in boundary and mixed-friction conditions of lubrication .

BIBLIOGRAPHY

1. Criddle, D. W. & A. L. Meader, Jr., "Viscosity & Elasticity of Oil Surfaces & Oil-Water Interfaces," *J. Appl. Phys., Vol. 26*, 1955, p. 832.
2. Cumper, C. W. N. & A. E. Alexander, "The Surface Chemistry of Proteins," *Trans. Faraday Soc., Vol. 46*, 1950, p. 235.
3. Sherman, P., "Water-in-Oil Emulsions, III, Properties of Interfacial Films of Sorbitan Sesquioleate," *J. Colloid Sci., Vol. 8*, 1953, p. 35.
4. Joly, M., "The Non-Newtonian Surface Viscosity," *Kolloid-Z., Vol. 126*, 1952, p. 35.
5. Alexander, A. E. & J. H. Schulman, "Molecular Interactions at Oil-Water Interfaces," *Trans. Faraday Soc., Vol. 36*, 1940, p. 960.
6. Sherman, P., "Studies in Water-in-Oil Emulsion, IV, The Influence of the Emulsifying Agent on the Viscosity of Water-in-Oil Emulsions of High Water Content," *J. Colloid Sci., Vol. 10*, 1955, p. 63.
7. Glasstone, S., *Textbook of Physical Chemistry*, D. Van Nostrand Co., Inc., New York, 2nd Edition, 1946.
8. Henniker, J. C., "Retardation of Flow in Narrow Capillaries," *J. Colloid Sci., Vol. 7*, 1952, p. 443.
9. Bielak, E. B., G. F. N. Calderwood & E. J. W. Mardles, "Lubrication: The Rate of Spreading & Creep of Oils & Other Liquids Over Solid Surfaces," Royal Aircraft Establishment Tech. Note, *Chem., Vol. 1245*, March 1955.
10. Henniker, J. C., "The Depth of the Surface Zone of a Liquid," *Revs. Mod. Phys., Vol. 21*, 1949, p. 322.
11. White, J. R., "Frictional Properties of Soaps at High Pressures," *Lubrication Engineering, Vol. 10*, 1954, p. 340.
12. Bowden, F. P. & D. Tabor, *The Friction & Lubrication of Solids*, Oxford University Press, London, 1950, p. 181, 209-210.
13. Neely, G. L., "High Oiliness — Low Wear," *SAE Transactions, Vol. 32*, 1937, p. 548; SAE Preprint No. 13, May 1937.
14. Harkins, W. D., *The Physical Chemistry of Surface Films*, Reinhold Publishing Co., New York, 1952, p. 144.

It's Detroit in '57

as the scene of the

ASLE 12th Annual Meeting & Exhibit

April 15-16-17 Sheraton-Cadillac Hotel

Radiation-Resistant Greases*

Greases typical of those commercially available were irradiated in an atomic pile and in other radiation facilities. Specially developed experimental greases were likewise exposed. After irradiation, standard grease tests were made and results were compared with data for unexposed greases. The tests evaluated physical properties, bearing life, oxidation, low temperature torque, copper corrosion, and wear.

Radiation altered consistency. Most greases softened initially but eventually became solid. Bearing life was reduced by 40-90% and oxidation resistance was also severely impaired. Other properties were affected to a lesser degree. Several experimental products which gave excellent results in standard tests before irradiation showed superior radiation resistance.

J. G. Carroll, R. O. Bolt & B. W. Hotten
California Research Corp.
576 Standard Ave.
Richmond, California

INTRODUCTION

Nuclear radiation is a new environment in which lubricating greases must function. It is superimposed on familiar variables such as temperature, load, and speed. Greases were exposed to radiation, initially with two objectives in mind: (1) to observe some of the effects of radiation on present commercial grease types, (2) to develop greases having improved resistance to radiation.

Initially, irradiations were made in the Materials Testing Reactor (MTR) located in Idaho. Samples were brought in and out of the pile through a shuttle tube referred to as the Hydraulic Rabbit Facility (VH-3). The damaging radiation in VH-3 consists mainly of neutrons and gamma rays. These neutrons and gamma rays extend over a wide range of energy, or ability to cause damage, and hence an expression for the level of radiation must be somewhat empirical. Most commonly, the radiation level, or reactor flux, is expressed in terms of the slow neutron component which can be measured by known methods.[1] The fast neutron and gamma ray components, which are the more damaging to organics,[2] occur in direct proportion to the slow neutrons in the pile. Techniques for determining the fast neutron and the gamma components of reactor flux are still experimental. There is some evidence that damage to organic materials depends on total energy absorbed[2] for all types of radiation even though mechanisms may differ.

Irradiations were also made in what is referred to as the Canal Source at the MTR. Here the damaging radiations consist solely of gamma rays. The gamma flux was monitored by techniques described in the literature.[3-5] Gamma exposures are most frequently expressed in terms of the roentgen (r) which may be considered as a quantity of absorbed gamma radiation. One Btu/lb. corresponds to $2.75 \times 10^5 r$.

In most applications requiring radiation-resistant lubricants, gamma rays will predominate. Gamma rays are also more convenient for research as they do not make materials radioactive. Exposure to neutrons leaves most materials radioactive. Such substances require special handling techniques in the laboratory.

Unpublished experiments show a rough correlation between the VH-3 facility and the Canal Source. A dosage of 10^{18} slow neutrons/sq. cm. approximates the damage done by a Canal Source gamma dosage of $10^9 r$. Within the range from $5 \times 10^6 r$ to $10^{10} r$, organic fluids and greases are sensitive to radiation. Below $5 \times 10^6 r$, damage to oils and greases is usually negligible; above $10^{10} r$, only the most resistant organic structures survive. In comparison, about $10^3 r$ total body dosage is considered lethal for humans.

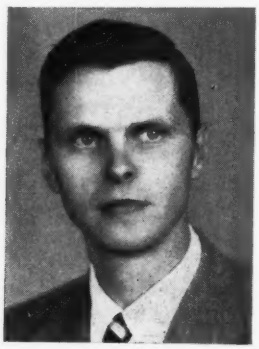
PILE IRRADIATED GREASES

For the tests carried out in Idaho in the VH-3 facility, the measured flux was about 1.3×10^{14} slow neutrons/sq. cm./sec. Samples were exposed for 120 and 600 minutes amounting to dosages of 10^{18} and 5×10^{18} slow neutrons/sq. cm. The dosages are considered accurate to about $\pm 10\%$. About 12 grams of each grease was irradiated in a magnesium capsule which had been sealed under an atmosphere of helium.

Previous work[6,7] had shown that aromatic fluids are more resistant than aliphatic fluids to radiation. Therefore, test samples included an experimental grease made from an alkylbenzene oil (mol. wt. 250), inhibited with didodecyl selenide and thickened with a siliceous agent,[8] "Estersil." Representative aviation greases that meet High Temperature

J. G. Carroll

R. O. Bolt



B. W. Hotten

*This work was conducted on AEC Contract AT(11-1)-174.

This paper was presented at the 3rd Annual ASLE-ASME Lubrication Conference, Atlantic City, October 8-10, 1956.

Table I

Inspections on Pile-Irradiated Greases

Grease	Dosage, Neutrons/ 10^{18} cm.^{2}	ASTM Worked Penetration	Induced Radio-activity mr/hr.[a]	Condition After Irradiation
MIL-L-3545	0	348	0	—
(Mineral Oil-Sodium Soap)	1	335	4	Tacky
	5	Too Hard	18	Brittle, porous solid
MIL-G-3278	0	286	0	
(Diester-Lithium Soap)	1	Too Hard	0.1	Brittle, porous solid
G-2	0	276	0	—
(Alkylbenzene-Estersil[b]	1	308	4	Tacky
with Didodecyl Selenide)	5	327	19	Grease-like

[a]At Contact, 18 Months after Exposure [1 milliroentgen (mr) = 0.001 roentgen (r)]; [b]Du Pont "Estersil."

Specification MIL-L-3545 and Low Temperature Specification MIL-G-3278 were also included. The effect of the irradiation was measured in terms of the consistency of the greases. Table I shows the results of the exposures.

At the lower dosage, the MIL-L-3545 product and the experimental grease showed a negligible amount of damage; the MIL-G-3278 grease became a brittle, porous solid. At the higher dosage, the MIL-L-3545 grease also became a solid; the experimental grease (G-2) retained good consistency. As indicated in Table I, the greases became radioactive, undoubtedly due to the activation of the inhibitor or the metallic component of the gelling agent.

A further source of damage during and after neutron irradiation is the supplementary radiation from the grease. This was calculated and is small for most greases.

GAMMA IRRADIATED GREASES

The gamma flux in the MTR Canal Source varied from $2 \times 10^6 r$/hr. to $2 \times 10^7 r$/hr. and dosages of $5 \times 10^8 r$ to $60 \times 10^8 r$ were used. This range should give approximately the same range of damage found in the pile irradiation. The values of gamma dosage are considered correct within $\pm 10\%$.

An aluminum pipe of 3 inches diameter was used as an outer canister for sample handling. Small samples of about 12 grams were placed in magnesium capsules or in glass vials. Larger quantities of about 150 grams were contained in common "tin cans." All types of containers were vented to the outer canister, which in turn was vented to the canal surface. Temperature during irradiation was about 80°F.

PHYSICAL PROPERTIES

Worked penetrations were determined on a series of greases to establish a pattern of consistency change as a function of gamma dosage. Table II shows results for three commercial greases and two experimental products. The latter greases were made with the alkylbenzene oil (mol. wt. 250) inhibited with didodecyl selenide. Grease G-2 was identical to that exposed previously to neutrons. The second experimental grease was gelled with sodium terephthalamate.[9]

Of particular note in Table II is the general pattern of a period of excessive softening prior to hardening. The limits of the penetrable, or semi-liquid, stage vary with the particular combination of oil and gelling agent and are, in one sense, a measure of radiation resistance. Grease G-2 was still soft and grease-like for the extreme dosage of $50 \times 10^8 r$.

Several experimental greases were made from sodium terephthalamate in various base oils including a mineral oil, a polyglycol, a diester, and an alkylnaphthalene (octadecyl alphamethylnaphthalene, mol. wt. 394); most greases contained didodecyl selenide. Consistency change for seven greases for a range of gamma dosage is shown in Table III. The unworked penetrations generally decrease until finally a hard solid is formed. All greases which reached $50 \times 10^8 r$ hardened to 0 penetration.

The worked penetration shows the general pattern of initial softening followed by hardening, as observed in Table II. The polyglycol and the aromatic greases retained consistency for the highest dosages.

For six of the seven greases irradiated, the ASTM drop-

Table II

Effect of Gamma Irradiation on the Consistency of Greases

Grease Type	MIL-L-3545	MIL-G-3278	Silicone	Experimental	G-2
Oil Type	Mineral Oil	Diester	Silicone	Alkylbenzene[a]	Alkylbenzene[a]
Gelling Agent	Sodium Soap	Lithium Soap	Lithium Soap	Terephthalamate	Estersil[b]
		ASTM Worked Penetration			
Gamma Dosage, 10^8r					
0	331	277	269	289	296
4	213	Semiliquid	289	289	—
9	Semiliquid	Semiliquid	Too Hard	308	—
26	Too Hard	Too Hard	Too Hard	400	—
30	Too Hard	Too Hard	Too Hard	359	—
50	Too Hard	Too Hard	Too Hard	—	388

[a]With Oxidation Inhibitor; [b]Du Pont "Estersil."

Table III

Change of Consistency with Gamma Irradiation

Grease	Gamma Dosage, 10^8r	ASTM Penetration Unworked	Worked
Mineral Oil-Sodium Soap[a]	0	212	289
	4	300	452
	18	185	382
Mineral Oil-Terephthalamate	0	208	239
	6	144	258
	23	21	Too Hard
	59	0	Too Hard
Mineral Oil-Terephthalamate[a]	0	196	239
	7	146	246
	26	32	Too Hard
	67	0	Too Hard
Polyglycol-Terephthalamate[a]	0	200	246
	6	87	212
	24	66	254
	62	0	Too Hard
Diester-Terephthalamate[a]	0	180	216
	6	131	218
	20	72	—
Alkylnaphthalene-Terephthalamate	0	231	254
	26	191	389
	50	9	Too Hard
Alkylnaphthalene-Terephthalamate[a]	0	269	260
	14	242	336
	32	227	376

[a]With Oxidation Inhibitor.

ping point remained at the initial value of 500+°F. That of the mineral oil-sodium soap grease changed from 475°F. to 346°F. for the dosage of 18×10^8r. A decrease of this magnitude is undesirable.

Bearing Performance

The performance of all greases in standard bearing tests[10] was shortened markedly by irradiation. In Table IV, bearing life before and after irradiation is shown for commercial and experimental greases.

Typical changes in bearing life for several additional greases are shown in Figure 1. Initial points are average values of several runs; points for irradiated samples are values of individual runs. These three greases show the range of impairment of performance, as noted in Table V.

Table VI

Effect of Irradiation on Static Oxidation Stability

Grease	Gamma Dosage, 10^8r	Pressure Drop, psi
Mineral Oil-Sodium Soap[a]	0	3
	4	11
Mineral Oil-Terephthalamate	0	7.5
	6	8
Polyglycol-Terephthalamate[a]	0	5
	7	16
Diester-Terephthalamate[a]	0	1
	6	11
Alkylnaphthalene-Terephthalamate	0	5[b]
	26	7
Alkylnaphthalene-Terephthalamate[a]	0	1.4
	14	9
	32	13.5

[a]With Oxidation Inhibitor; [b]Estimated.

Table IV

The Effects of Gamma Irradiation on Bearing Performance

	Grease	Gamma Dosage, 10^8r	Bearing Life, Hours at 10,000 rpm. 250°F	300°F
1.	MIL-L-3545	0	—	1201,1226
	Mineral Oil-Sodium Soap	3.8	—	221
		8.9	—	448
2.	MIL-G-3278	0	638,1590	—
	Diester-Lithium Soap	3.8	317	—
		8.9	278	—
3.	Experimental Alkylbenzene[a]-Terephthalamate	0	—	220
		3.8	—	154
		8.9	—	155
		30.0	—	39

[a]With Oxidation Inhibitor.

Table V

Effect of Gamma Irradiation on Bearing Life

Grease	% of Initial Bearing Life After 6.5×10^8r	
Polyglycol-Terephthalamate[a]	6	at 250°F.
Mineral Oil-Sodium Soap[a]	36	at 300°F
Alkylnaphthalene-Terephthalamate[a]	62	at 300°F

[a]With Oxidation Inhibitor.

It is evident that greases of enhanced radiation resistance can be prepared from alkylaromatic oils and selected gelling agents. Figure 1 also shows that the original performance of the experimental greases is excellent.

Oxidation Stability

Oxidation stability is usually determined for a lubricating grease in an oxidation bomb apparatus.[11] Typical results for the greases before and after irradiation are shown in Table VI. Oxidation stability was poorer for the irradiated greases. The mineral oil-terephthalamate grease showed little change after irradiation. The mineral oil-sodium soap, the polyglycol, and the diester greases were more susceptible to oxidation after irradiation than before. This is most marked for the diester grease, which had excellent oxidation stability before irradiation. For these greases, the selenide additive is very effective in protecting against oxidation before irradiation; however, this gain decreases during irradiation.

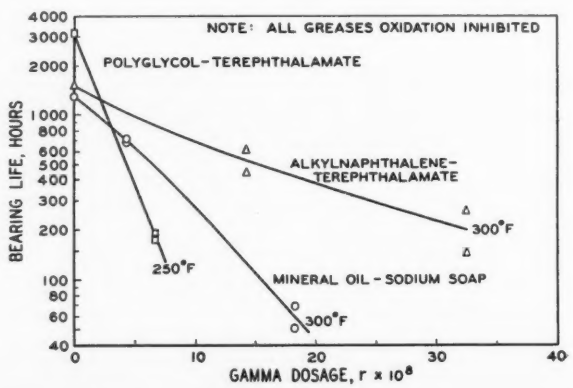


Figure 1. Effect of radiation on bearing life.

Table VII

Low Temperature Torque as Affected by Irradiation

Grease	Gamma Dosage, 10^8r	Seconds Per Revolution at 0°F
Mineral Oil-Sodium Soap[a]	0	1
	4	2
	18	200
Mineral Oil-Terephthalamate	0	1
	6	6
Polyglycol-Terephthalamate[a]	0	<1
	7	1
Alkylaromatic-Terephthalamate[a]	0	1
	14	3

[a]With Oxidation Inhibitor.

Copper Corrosion

Corrosivity[12] was measured with a copper strip half submerged in the grease and maintained in this position for 24 hours at 210°F. Figure 2 shows typical examples for several of the greases being discussed. Radiation increased copper corrosion noticeably only in the polyglycol-terephthalamate grease.

Low Temperature Torque

Several of the greases were examined by means of a torque test for low temperature property changes after irradiation. Standard equipment[13] was used, and the results were in terms of seconds per revolution at 0°F. The torque at low temperature was increased by irradiation. This was minor at about $5 \times 10^8 r$ but increased for higher dosages. Table VII shows typical data. These values show that low temperature torque increases with irradiation and that the more radiation-stable product changes less with increasing dosage.

Wear

Two specifications for aircraft greases contain an instrument gear wear test.[14] In the specification test (Navy Gear Wear), two small, spiral bevel gears are run in oscillating motion under 5 and 10-pound loads. For most of the greases tested, wear properties did not appear to be significantly changed. Typical values are shown in Table VIII.

Evaporation

Evaporation in terms of weight loss was determined by exposing the greases in small dishes in an oven for 18 hours at 300°F. In general, evaporation was not significantly altered by irradiation. Typical data are shown in Table IX.

Table IX

Effect of Irradiation on Evaporation

Grease	Gamma Dosage, 10^8r	Evaporation; 18 Hours at 300°F % Loss
Mineral Oil-Sodium Soap[a]	0	4.7
	4	8.1
Mineral Oil-Terephthalamate	0	2.2
	6	2.9
Mineral Oil-Terephthalamate[a]	0	3.2
	7	4.7
Alkylaromatic-Terephthalamate[a]	0	2.9
	32	4.1

[a]With Oxidation Inhibitor.

Table VIII

Wear Before and After Irradiation—Navy Gear Wear Test

Grease	Gamma Dosage, 10^8r	Weight Loss of Brass Gear mg/1000 Cycles	
		5-lb Load	10-lb Load
Mineral Oil-Sodium Soap[a]	0	1.6	5.8
	4	1.5	4.7
Polyglycol-Terephthalamate	0	1.8	3.0
	7	1.7	4.9
Diester-Terephthalamate[a]	0	0.9	stripped
	6	2.6	gears
Alkylaromatic-Terephthalamate[a]	0	2.7	6.5
	14	2.4	5.8
	32	1.4	6.2

[a]With Oxidation Inhibitor.

SUMMARY

The data discussed represent a brief survey of the effects of radiation on some of the properties and performance characteristics of lubricating greases. Greases typical of those available commercially were exposed in an atomic pile for a dosage expressed as 5×10^{18} slow neutrons/sq. cm. Greases of this type were also exposed to pure gamma rays for dosages from $4 \times 10^8 r$ to $60 \times 10^8 r$. The results of these tests, along with previous knowledge, indicated the direction in which to develop greases of enhanced radiation resistance. Such experimental greases were made and evaluated.

Within the limits of the irradiation and test conditions, certain conclusions can be made.

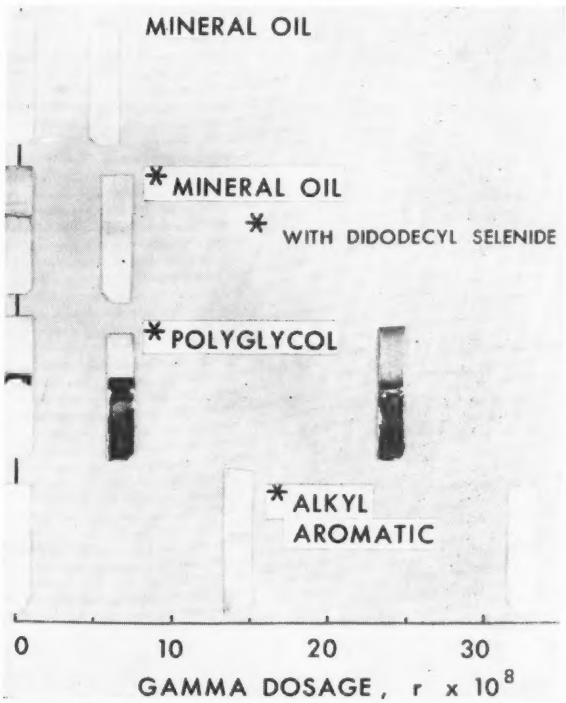


Figure 2. Copper corrosion of irradiated greases gelled with terephthalamate.

(1) A pile exposure expressed as 5×10^{18} slow neutrons/sq. cm. reduced conventional greases to brittle, porous solids.

(2) Gamma radiation of about $6 \times 10^{8}r$ markedly altered the consistency of greases. Initial softening of the worked consistency was followed by eventual hardening.

(3) A grease made from alkylbenzene inhibited with an organic selenide and gelled with Estersil was still plastic after $50 \times 10^{8}r$. Conventional greases were too hard to work after 10% to 50% of this gamma dosage.

(4) After about $6 \times 10^{8}r$ of gamma exposure, bearing life was reduced from 2 to 20 fold; oxidation stability was significantly impaired; and low temperature torque was impaired to a minor degree.

(5) Copper corrosivity, evaporation, and wear properties, as measured by the Navy Gear Wear Tester, were not greatly increased by irradiation.

(6) Greases made from alkylaromatic fluids and selected gelling agents gave excellent results in standard tests and showed superior radiation resistance after $32 \times 10^{8}r$.

BIBLIOGRAPHY

1. Littler, D. J. & R. H. Thomas, Atomic Energy Research Establishment, Harwell, Document No. AERE-R/R-1019, September 1952.
2. Calkins, V. P., *Nucleonics, Vol. 12*, No. 9, September 1954.
3. Weiss, J., *Nucleonics, Vol. 10*, No. 7, July 1952, p. 28.
4. Jenks, G. H., W. M. Breazeale & J. J. Harrison, U. S. Atomic Energy Commission Document No. ORNL 923, January 1951.
5. Hogg, C. H., U. S. Atomic Energy Commission Document No. IDO-16093-PPC, September 1953.
6. Bolt, R. O. & J. G. Carroll, Proceedings of the International Conference on Peacetime Uses of Atomic Energy, Geneva, Switzerland, August 1955, *Vol.* 7, 1956, p. 549.
7. Carroll, J. G. & R. O. Bolt, "Lubrication in the Presence of Nuclear Radiation," *Lubrication Engineering, Vol. 12*, No. 5, September-October 1956, pp. 305-309.
8. Meyer, G. C. & R. O. Braendle, "Estersils — A New Class of Siliceous Thickening Agents," *NLGI Spokesman, Vol. 18*, No. 9, 1956, pp. 8-16.
9. Dreher, J. L., B. W. Hotten & C. F. Carter, "A New Synthetic Thickener for Multipurpose Lubricating Greases," 1956 Annual Meeting of the National Lubricating Grease Institute.
10. Federal Test Method Standard No. 791, December 15, 1955; Method 331.1.
11. Ibid, Method 3453.1.
12. Ibid, Method 5309.2.
13. Military Specification MIL-G-3278, August 25, 1950; Section 4.2.2.6.
14. Ibid, Section 4.2.2.8.

Section News

BALTIMORE, January meeting. H. D. Plumly, Chief Chemist for the Baltimore & Ohio Railroad, presented a paper entitled "Journal Box Lubrication" covering the problems encountered in journal box lubrication, together with the latest materials and methods designed to improve journal box performance.

February. "Versatility of Solid Lubricants from Packing to Coating," by Mrs. Frances Popejoy, Chief Chemist, Allen Lubricants Co. (Submitted by C. J. Devries, Sec'y.)

CLEVELAND, January. Dr. D. F. Wilcock, General Electric Co., presented a paper entitled "Fundamentals of Ball Bearing Lubrication."

February. "Cutting & Grinding Compounds," by a representative of the Master Chemical Co.

March 26. "Petroleum-Base Rust Preventives," by a representative of the Esso Standard Oil Co.

April 23. "Filtration," by J. R. McCoy, Commercial Filters Corp. (Submitted by G. L. Smith, Sec'y.)

KANSAS CITY, January. M. T. Lavik presented a paper entitled "Molybdenum Disulfide and Other Solid Lubricants." (Submitted by J. D. Jenkins, Sec'y.)

MILWAUKEE, January. A. S. Morrow, Shell Oil Co., presented a paper entitled "Cleaning & Care of Lubrication Systems," followed by a film entitled "Lubricating Oil's Amazing Molecules." (Submitted by R. K. Johnson, Sec'y.)

N. CALIFORNIA, February. R. Atkinson, Equipment Maintenance Manager of the Guy F. Atkinson Co., presented a paper entitled "Lubrication Problems of Large Contractors." Abstract: "Modern heavy construction work is almost synonomous with mechanization and, as always, we find lubrication the life blood of mechanization. Today industry offers the contractor a wide variety of lubricant products, dispensing equipment, and advice. The selection and combination of these into an effective and economical lube program stands as the basic lubrication problem of any contractor. Specific issues which the contractor must resolve in order to solve his basic problems are those of personnel, product selection, job schedules, dispensing equipment, and records. In addition, specific problems arise because of job conditions, i.e. the inability of the average construction personnel to understand the chemistry and physics of lubrication; the economic problem of whether to use a few expensive products, or to use the least expensive product acceptable for each application regardless of how many products are required." (Submitted by G. H. Hommer, Sec'y.)

SAGINAW VALLEY, January. Election of Officers (see ASLE Directory), followed by a movie entitled "Wyoming's Pressure-Cooker." (Submitted by J. A. Norton, Past Sec'y.)

WHEELING, November '56. W. S. Fuhr (Hanna Coal Div.) & R. R. Chrisman (American Oil Co.) presented a paper entitled "Lubrication & Maintenance of Deep- & Strip-Mining Equipment."

December. Annual Christmas Party.

(Continued on p. 167)

A Dual-Purpose Film Strength Additive for Engine Crankcase Oils

G. C. Templeman
The Ohio Oil Co.
Refining Dept.
Findlay, Ohio

The following article describes a film strength additive for engine crankcase oils which: (1) increases film strength by adsorption onto metal surfaces, and (2) reacts or alloys with metals just before seizure conditions, permitting metal flow until high points are leveled and seizure obviated.

It has long been theorized that agents soluble in mineral oil which possess the property of forming a very thin or molecular film on sliding metal surfaces, contribute considerably to the business of engine lubrication. Such materials when added to mineral oils make a dramatic demonstration in the Almen Machine or similar "Nut-Cracking" devices. In evaluating a new film strength improver, the following information was gathered by the Refining Chemical Research Department of The Ohio Oil Company. Perhaps it will be of interest to others concerned with such matters.

INTRODUCTION

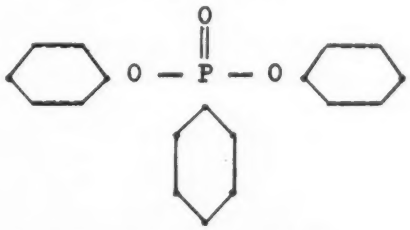
The story begins when a search was instigated for a new film strength improver with definite positive attributes. Many substances had been suggested and were considered, but most of them had some characteristic not conducive to good lubrication, particularly in the modern automobile engine.

Just at the end of the last World War, an American Task Force was sent to Germany to microfilm the records of all German industrial and scientific establishments. In the catalogs of the results of this effort, the writer noted several reports having to do with work accomplished relative to high film strength lubricants. This material was secured on microfilm[1] and the huge task began of reviewing the film, photographing the pertinent articles, and studying them. As usual the Germans had been very thorough, having evaluated all the laboratory equipment used in testing film strengths, and having prepared and tested hundreds of compounds. Some, quite new, were exceptional. The best was synthesized by the I. G. Farbenindustrie, further evaluated, and finally utilized in aircraft engine break-in oil. They had been losing about 10 Benz aircraft engines out of every 100 during break-in tests. With the I. G. 891 added, only an occasional engine out of each 100 failed in the break-in runs. It is interesting to note here that the Germans had much of the information this country possessed on the subject, including some U. S. Air Force reports. They acknowledged the U. S. was ahead in this film strength business. Their work was never actually completed, probably because bombs destroyed their facilities and their incentive for work. From their results, however, the writer was able to learn much on the subject and, more important, get an idea of the most promising types of compounds.

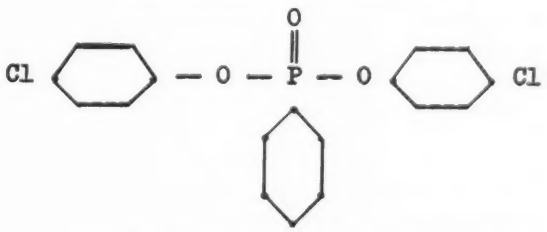
The tremendous amount of work accomplished by the Germans led them to conclude phosphorus compounds gave the best promise for superior film strength additives. They further determined that the ideal compound would consist of molecules which, in addition to the phosphorus atom, should contain a further particularly active group such as hydroxyl or chlorine atoms. These active groups afford the means by which the molecules attach themselves to metal sliding surfaces in molecular films. Such films must exist, otherwise the action of such trifling quantities as 0.1% of compound in a mineral oil would be impossible to explain.

The Germans, however, did not consider this adsorption as the decisive factor in the lubrication improvements noted. They reasoned it was the reaction with the metal surfaces. Even the most finely prepared metal surfaces have high points or jags present. When these come into contact with another sliding surface, especially under pressure, the film of lubricant may be torn or ruptured, permitting metal to metal contact at the high points and, therefore, the seizing of the metal parts. Now, if the film strength additive reacts with the hot metal high points just before seizure, forming a low-melting phosphide, the high points will flow, the pressure will be relieved, and the temperature will be reduced. No further reaction occurs at this point, and the over-all result is a highly polished, extremely smooth surface, easy to lubricate.

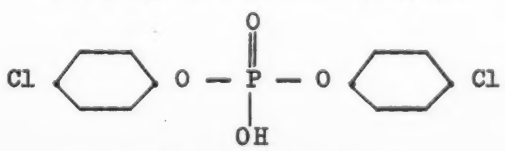
The German scientists were highly pleased with the performance of such compounds as:



Phenyl phosphinic acid diphenyl ester



Phenyl phosphinic acid di-*p*-chlorophenyl ester



Di-*p*-chlorophenyl Phosphate

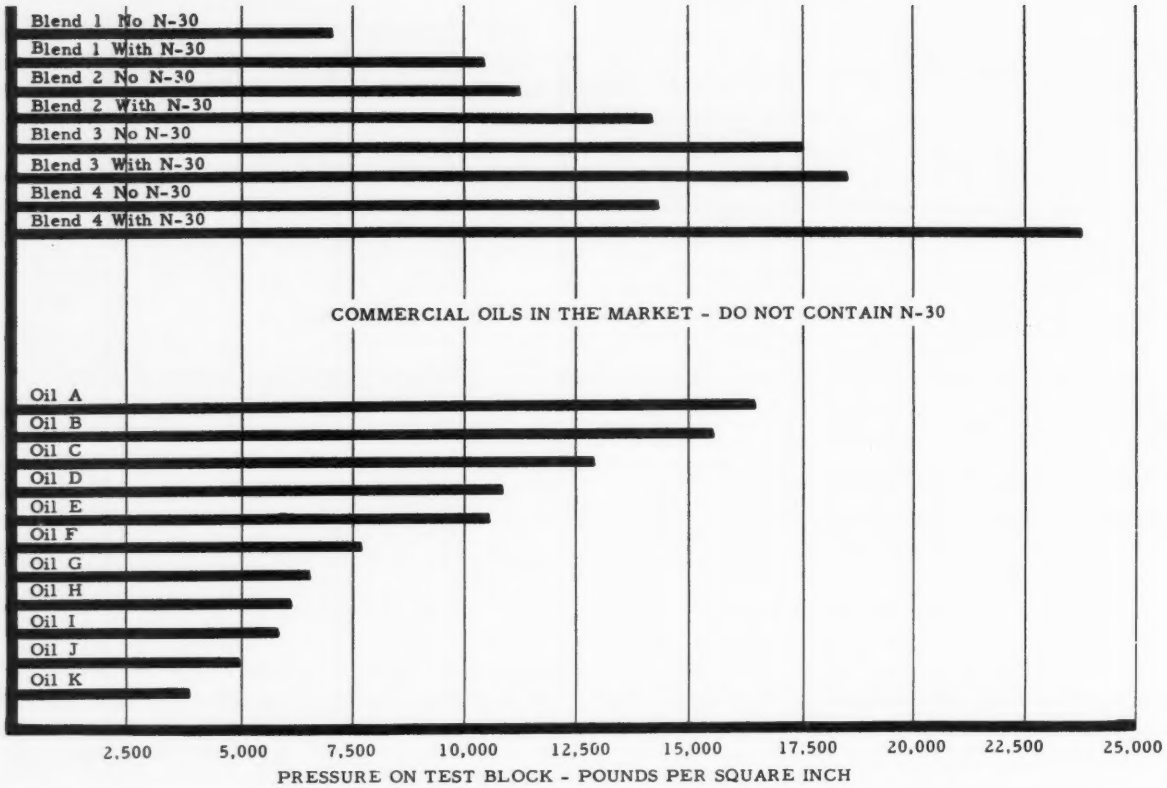
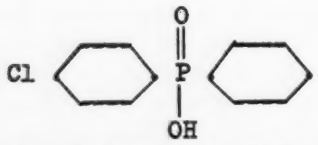


Figure 1. Timken rating of SAE 20 motor oils.

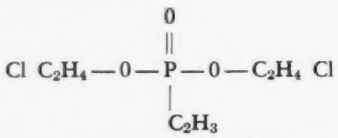


P-chlorophenyl phenyl phosphinic acid

Two of the compounds tested by the Germans were obtained and evaluated by means available to us. We considered the results quite moderate. However, we were unable to obtain any of the few compounds rated by the Germans as extremely active.

EXPERIMENTAL

We were able to obtain[2] a sample of bis beta chloroethyl vinyl phosphonate.[3]



This compound has acquired the nickname of N-30.

In our bench testing, N-30 appeared even more active than those derivatives evaluated by the Germans, and it seemed to possess all the other characteristics of a good film strength improver and lubricating oil additive. Bar graphs (Figures 1 & 2) show the Timken ratings of several blends of SAE 20 and 10W-30 motor oils compounded with commercially available additives both with and without N-30. It will be noted those blends containing N-30 have increased load-carrying capacity. For comparison, the Timken ratings of various commercial motor oils in the market are shown in the lower part of each graph.

In order to further evaluate N-30 as a film strength additive and obtain some evidence of the polishing action, a series of truck engine tests were undertaken. The first resulting pistons appeared to have an unusual sheen, difficult to describe, but definitely apparent. Electron micrographs were prepared[4] of the piston surface on the bright area existing on the major thrust side immediately below the oil ring groove. This area was selected for examination because, as the pistons came from the truck engines after running in test cells, the normal amount of carbon and varnish were present, and the problem was to study the metal surface where rubbing had occurred. We did not wish to disturb the metal surface by cleaning in any fashion, and also, the area chosen had to be amenable to the replica technique involved. The above described area seemed best suited to our purpose. The metal was bright and clean, and preparation of replicas was possible on this area. Rubbing and possible metal to metal contact appeared likely, and we believe these do occur between high points and the opposing cylinder wall surface. Results are shown in Figures 3 and 4. The magnification was 2400X. The sheen noted was explained as the well reflected light from the clean, smooth surface formed when N-30 was present. The other surface, rough and with small carbon or sludge deposits, did not reflect as much light.

Of course, not all pistons from the various truck engines had traveled the same distance — running time, nor had all engines experienced the same operating history. To minimize these differences, electron micrographs were taken of L-1 pistons which had been run 480 hours in qualification and evaluation tests of crankcase oils, with and

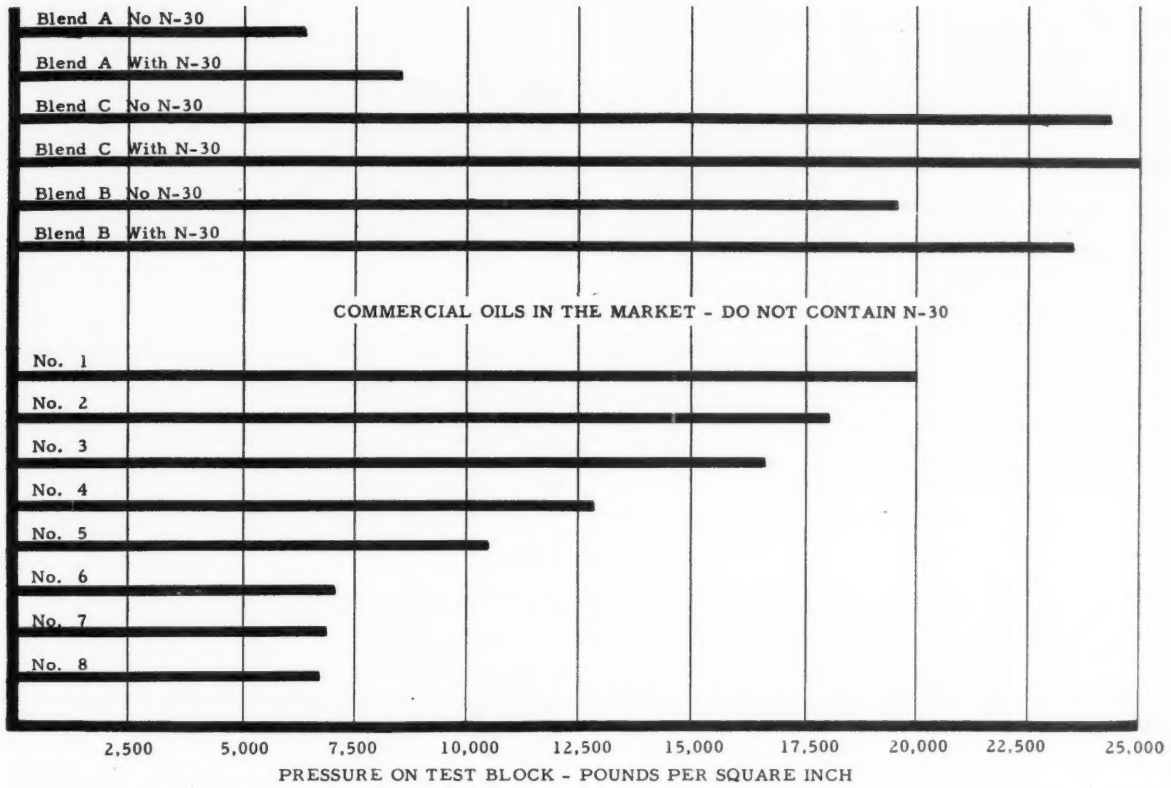


Figure 2. Timken rating of 10 W-30 motor oils.

without N-30 additive. These photographs were of the same area on the piston. Of course, six to ten shots were taken of different parts of the area to eliminate chance as much as possible. In all cases where N-30 was added to the oil, its effect on the piston surface was very noticeable in the microphotographs. This was true on the tougher aluminum alloy pistons containing about 13% silicon, as well as on the L-1 pistons of aluminum alloy with copper.

These electron micrographs (Figures 5, 6, 7, 8 & 9) were at 4000X and are inverted. That is, they were prepared from collodion replicas and a hole is a high point, a valley a ridge, and vice versa. In other words, you see a reverse image of the surface.

Several electron micrographs (Figures 10 & 11) were taken of ring faces, that area subjected to rubbing contact with the cylinder wall. These were at 4000X and from carbon replicas, hence not inverted. You see the surface as it exists. The rough small projections on the surface of the

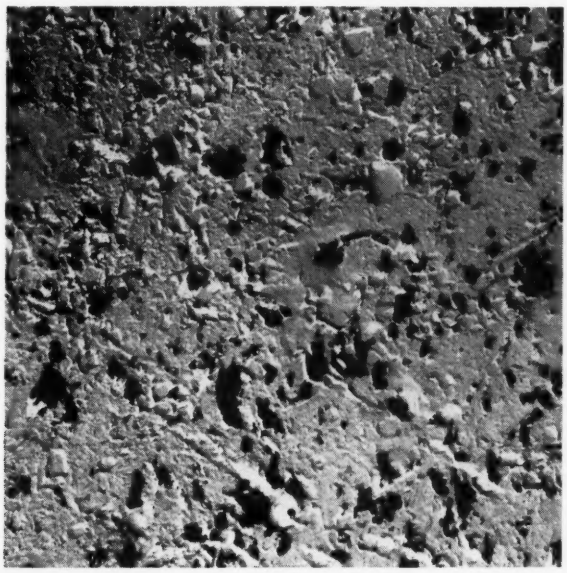


Figure 3. Commercial lubricating oil; no N-30. (2400X)

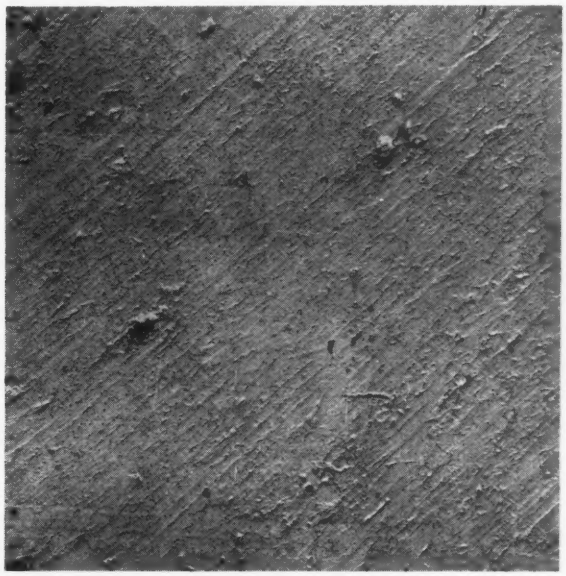


Figure 4. Commercial lubricating oil with N-30. (2400X)

Figure 5. A new unused L-1 piston (remember this is an inverted image). (4000X)

Figure 6. L-1 piston; 10W-30 Mil Level motor oil; no N-30. (4000X)

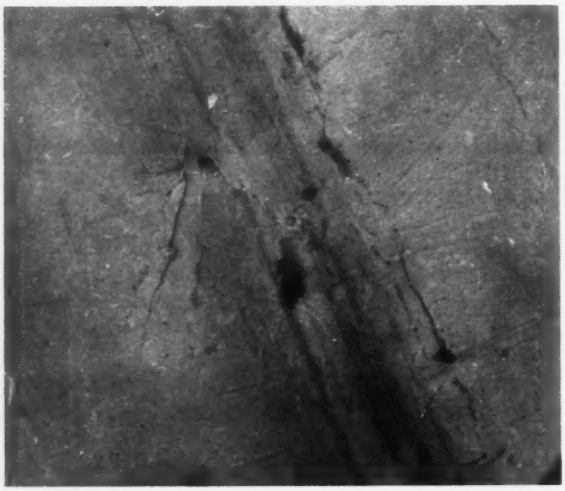


Figure 7. L-1 piston; same oil as in Fig. 4, but with N-30 (more reflected light gives a lighter picture). (4000X)

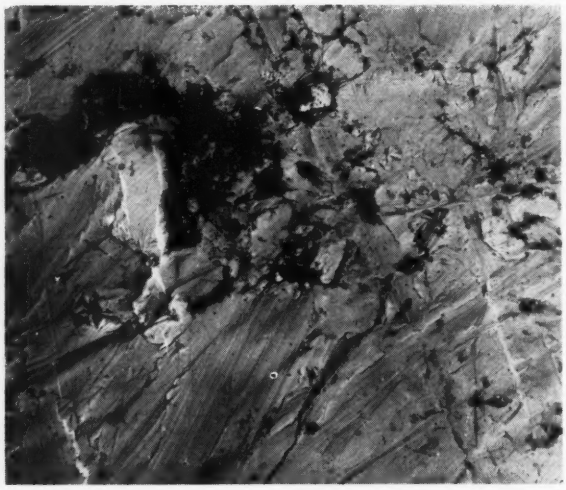


Figure 8. L-1 piston; Supplement 1 motor oil; no N-30. (4000X)

Figure 9. L-1 piston; same oil as in Fig. 6, but with N-30. (4000X)

Figure 10. L-1 piston ring; Supplement 1 motor oil; no N-30 (carbon replica — direct image of the ring face surface).

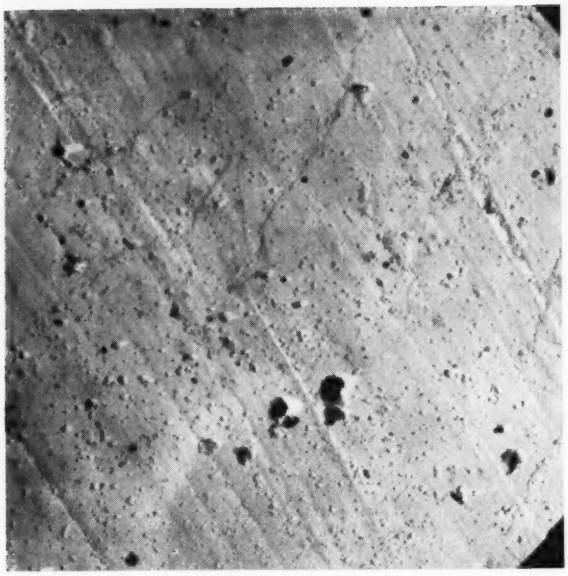


Figure 11. L-1 piston ring; same oil as in Fig. 8, but with N-30 (carbon replica — direct image of the ring face surface). (4000X)

ring faces are probably dirt, which accumulated through handling before the electron micrographs could be prepared.

SUMMARY

Additional experiments at the University of Illinois under the direction of Dr. G. L. Clark led to the following conclusion:

"The formation of metal phosphides is experimentally proved by the x-ray fluorescence spectrographic technique. In this technique, primary x-rays strike upon the surface of the specimen which has been treated with N-30. This permits the excitation of x-rays which are characteristic of the chemical elements present in the surface; the beam so excited is analyzed on the x-ray spectrometer by means of a crystal and detector.

"All these experiments proved a high concentration of phosphorus in the surface layers as the result of reaction between the metal and the phosphorus containing additive. X-ray diffraction analysis has proved that this layer consists primarily of iron phosphide. The metal itself has a very small percentage of phosphorus as an essential constituent of the piston alloy; however, after reaction with N-30, the concentration of phosphorus in the surface is many hundreds of times as great as it is in the body of the alloy itself.

"Phosphides are fairly stable compounds with considerably lower melting points than the corresponding metals or alloys from which the pistons are made. Consequently, the smoothing action comes from this tendency of the phosphide in the surface to melt slightly and smooth itself out."

We believe the electron micrographs speak for themselves, and that N-30, in addition to increasing oil film strength, reacts with metal surfaces causing metal flow, obviating metal seizure, and resulting in smoother, cleaner metal surfaces particularly where high pressures exist.

BIBLIOGRAPHY

1. Microfilm reel T.O.M. 248, Photoduplication Service, Library of Congress, Washington 25, D. C.
2. From the Monsanto Chemical Co.
3. Patent applied for by The Ohio Oil Co. on lubricant compositions containing this additive or compounds of this type.
4. This work was done by Dr. G. L. Clark, Research Professor of Analytical Chemistry, University of Illinois.

Foreign Lubrication Abstracts

(This is the eleventh in a series of abstracts of translations of Foreign articles on lubrication, by Henry Brutcher. Copies of the full translations are available, at the indicated prices, by writing Mr. Brutcher at P. O. Box 157, Altadena, Calif.)

Sulfidizing of Machine Parts & Tools, by P. A. Mishin & Ya. S. Buraya; "Vestnik Mashionstroeniya," Vol. 25, No. 7, 1955, pp. 70-74; 6 figs., 2 tables, 2900 words. Study of sulfur impregnation of steels and gray iron, with special reference to selection of best sulfidizing agent and temperature, and to highest resistance to seizure and wear of sulfidized mating parts. Composition of sulfidizing baths for low temperature (170-200° C. = 340-390° F.), medium (540-570° C. = 1005-1060° F.), and high (850-900° C. = 1560-1650° F.) temperature treatments; application of results to sulfidizing a great many different vehicle and machine components, also tools. Materials sulfidized and tested: 0.12% C plain steel with extra low S and P; 0.20% C plain steel; 0.30% C, 0.8-1.1% Cr steel; 0.12% C, 0.6-0.9% Cr, 1.5-2.0% Ni steel; 0.90% C, 4.3% Cr, 9% W, 2.4% V HS steel; gray iron. Sulfidizing with simultaneous other chemical surface, or heat, treatments. Test procedure for wear and seizure resistance; superior performance of sulfidized as against carburized or quenched plus tempered parts. Results of microexamination (Fig. 1). Data on effect of sulfidizing on wear resistance and tendency to scoring and seizure of moving parts (Table I). Need for further development work on process. Appendix. (Order No. 3651, price $6.90)

On the Connection Between Static & Kinetic Friction, by N. F. Kunin & G. D. Lomakin; "Zhurnal Tekhn. Fiziki," Vol. 24, No. 8, 1954, pp. 1367-1370; 2 figs., 1500 words. Reasons for discontinuous change in frictional force in the transition from static to kinetic friction. Study of peculiarities of this change in frictional force with metals, as an example of ordered microrupture, strain-hardening, and relaxation effects. Influence of variation in rate of application of tangential force to produce mutual displacement, upon the magnitude of the discontinuity. Tribograms for various conditions of rupture (Fig. 2). Development of a relation between the coefficients of static and kinetic friction. (Order No. 3650, price $3.00)

Investigation of Wear Resistance of Sulfidized High-Speed Cutting Tools, by E. P. Nadienskaya; "Stanki I Instrument," Vol. 26, No. 2, 1955, pp. 11-17; 6 figs., 8 tables, 2300 words. Effect of variation of cutting speed and machining time upon wear of high-speed cutting tools, heat treated in the conventional way; sulfidized or cyanided, resp. Results of study of wear using a radioactive method as well as an ordinary frictional wear testing machine. Does sulfidizing of HS tools actually give favorable results? Comparison of author's laboratory treatment with the Minsk Auto Works industrial sulfur impregnating treatment for effect on tool performance under

(Continued on p. 164)

Dynamic Demulsibility Characteristics of Oils

The methods currently used to determine the demulsibility characteristics of circulating oils are quite empirical and afford little or no correlation with actual field performance. The Dynamic Demulsibility Apparatus constitutes a realistic approach as it permits the evaluation of demulsibility characteristics essentially under field conditions. Data obtained by the conventional methods and by the Dynamic Demulsibility Test using a variety of lubricants are presented. The data indicate the test to be of value to both the research chemist and consumers.

E. W. Brennan & R. G. Moyer
The Pure Oil Company
Research & Development Labs.
Crystal Lake, Illinois

Many large industrial machines are equipped with an oil circulating system consisting of a reservoir from which the oil is pumped to those parts to be lubricated, and to which the oil returns. Quite often, heat exchangers and purification equipment are associated with the circulating system. Typical examples of industrial machinery of this type are steam turbines, rolling mills, hydraulic presses, and paper making machines.

In many cases the lubricant is subject to contamination with water as a direct result of the processes involved or operating conditions. Thus, one of the major performance requirements of circulating oils is that they possess "good demulsibility," by which is meant the ability of the oil to separate from water after the oil and water have been intimately contacted.

An oil which has poor demulsibility characteristics will emulsify with water and, in some cases, form gummy or sludge-like material. This results in an impairment of the flow and lubricating characteristics of the oil. In certain types of equipment the circulating oil is used for the actuation of controls in which the gummy or sludge-like material could clog the fine passage-ways in the servo-mechanisms so that no real control of these machines would be possib'e. Emulsification results in loss of oil when liquid must be drawn from the bottom of the reservoir to compensate for the increased liquid volume due to the contamination with water. If emulsification continues with periodic or continuous removal of oil with the water at the bottom, the emulsion will eventually contain sufficient water to impair lubrication.

The lubrication chemists and engineers recognize the need for some means of measuring the demulsibility characteristics of lubricating oils. Two methods commonly employed in measuring this property are the Herschel Demulsibility Test and the Steam Emulsion Number Method or, as it is officially known, Tentative Method of Test for Steam Emulsion of Lubricating Oils, ASTM D 157-51T.

In the Herschel Test, water and oil are mixed under prescribed conditions with a stirring paddle for a definite period of time. The oil-water sample is then allowed to set, and observations are made as to the extent of water separation.

In the Steam Emulsion Number Method, steam is passed into the oil sample under specified conditions for a period of time, the water-contaminated sample is then allowed to set, and the rate of water separation is measured.

These are two generally recognized methods for determining demulsibility; however, there is little or no correlation of the data obtained by the test methods for additive oils with actual field performance. In the case of such circulating oils as hydraulic, turbine, and paper machine oils the Steam Emulsion Number Method results have no real significance, since these oils contain rust and oxidation inhibitors, E.P. additives, etc., and the scope of the method specifically states that it is to be applied to uninhibited oils. It is stated in *The Significance of ASTM Tests,* 3rd Edition, ASTM D-2, that "Steam Emulsion Numbers determined by D 157 on turbine oils inhibited against oxidation and rust formation are unreliable, as shown by correlation with results obtained in service". Incidentally, despite this self-imposed limitation of the method, many consumers place a Steam Emulsion Number requirement in turbine and hydraulic oil specifications.

DYNAMIC DEMULSIBILITY TEST

Our Company undertook a research program to develop a circulating oil to be used in the lubrication of the roller bearings or precision-type sleeve bearings which support the dryer rolls found in the "dry end" of a paper-making machine. The machine and process requirements are such that the oil must keep the system free from deposits, paper dust, and water, and must have high load-

E. W. Brennan

R. G. Moyer

This paper was presented at the ASLE 11th Annual Meeting, Pittsburgh, April 4, 1956.

carrying capacity. Generalizing, the oil must have the following characteristics: rust inhibition, oxidation inhibition, detergency, foam inhibition, load-carrying capacity, and good demulsibility.

In order to establish the required performance levels of a high-grade paper machine oil, several commercially available oils were evaluated by bench tests. Differences in all the properties were observed with the exception of demulsibility. With few exceptions all of the oils had Steam Emulsion Numbers of 1200+, and Herschel Demulsibility values at 130°F. of <50. The values "1200" and "50" are the respective tests limits. In other words, these oils rated very poorly from a demulsibility viewpoint. A field survey revealed that these oils varied in demulsibility in actual service from "good" to "fair".

It was believed that this lack of correlation could be traced to the basic differences between laboratory and field methods of water contamination. In the former, water is added batchwise; whereas in the latter, it is continuous. A piece of equipment which would permit continuous contamination was devised by The Pure Oil Company Research & Development Laboratories, and is called the Dynamic Demulsibility Apparatus. The apparatus and flow diagram are shown in Figures 1 and 1A, respectively.

In developing this apparatus, the reservoir size and circulating rate were chosen to produce a residence time approximately two-thirds of that existing in the circulating system of a Kraft paper-making machine. The water contamination rate was selected to approximate the maximum normally encountered in this machine. Stirring conditions were such as to insure complete mixing of the water and oil. Lesser stirring rates resulted in the formation of large water droplets which separated immediately from the oil phase.

While the individual test conditions may not have been optimum for any particular lubricant, the original choice of test conditions permitted differentiation between various oils and oil compositions. The investigation of the effects of the different variables may be of academic value and interest; however, no attempt was made to determine these effects because of the success enjoyed with the original choices.

The test consists of continuous contamination of the circulating oil with water at the rate of 5% of the circulation rate. The oil and water are intimately contacted in a mixing chamber by means of a T-blade stirrer. The contaminated oil is pumped to the reservoir where it enjoys a residence time of 37½ minutes. The contamination continues for a period of 6 hours during which time the reservoir is tapped periodically to offset the increase in volume due to the added water. At the end of the test period, the concentration of water entrained in the oil at the top of the reservoir is measured by centrifuging a sample of the oil diluted with precipitation naphtha. The concentration of water at the draw-off point is determined by centrifuging an undiluted sample. With certain oils there is a thin emulsion in the water phase. For simplification and in consideration of the accuracy of the measurements, the emulsion was considered as all water.

TEST RESULTS

It has been found possible to determine the dynamic demulsibility characteristics, those exhibited in industrial equipment, of a variety of lubricants. The data presented cover base oils, turbine oils, and paper machine oils. It is believed that these data illustrate the wide applicability of the Dynamic Demulsibility Apparatus.

Base Oils

As might be expected, some changes must be made in the test temperature for oils of different viscosities. Table I presents data for the 150 and 550 SUS at 100° F. base oils. The Dynamic Demulsibility Test (DDT) data

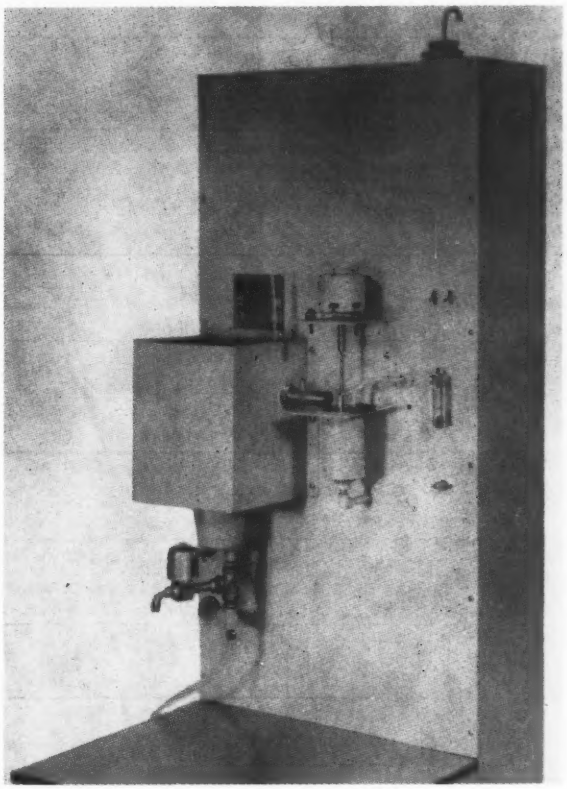


Figure 1. Dynamic Demulsibility Apparatus.

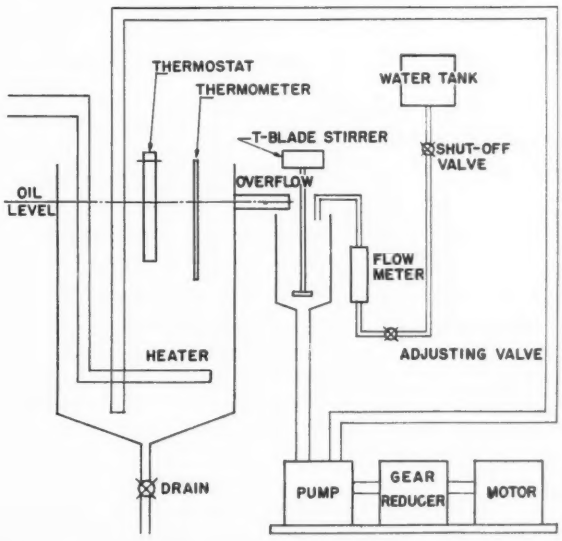


Figure 1-A. Flow diagram of Dynamic Demulsibility Apparatus.

Table I

Base Oil

Oil	S.E. No.	Herschel Demuls. at 130° F.	DDT at 80° F. % Water at Top	DDT at 80° F. % Water at Bottom
		150 SUS		
Gulf Coastal	123	300	7.0	99
Penn.	86	810	3.0	99.5
MCSR*	82	405	1.6	100
		550 SUS	DDT at 130° F.	
Gulf Coastal	636	<50	7.0	99
Penn.	1020	<50	7.0	88
MCSR*	780	92	3.2	97
MCCR**	525	<50	4.4	100

*Mid-Continent Solvent Refined.
**Mid-Continent Conventional Refined.

Table II

Turbine Oil, 150 SUS

Oil	S.E. No.	Herschel Demuls. at 130° F.	DDT at 80° F. % Water at Top	DDT at 80° F. % Water at Bottom
T.O. 1	238	96	5.5	100
T.O. 2	96	440	2.6	100
T.O. 3	109	340	5.0	90
T.O. 4	79	780	7.0	98
T.O. 5	116	400	5.0	95

Table III

Turbine Oils, M.S. 2190T, 450 SUS

Oil	S.E. No.	Herschel Demuls. at 130° F.	DDT at 130° F. % Water at Top	DDT at 130° F. % Water at Bottom
T.O. 6	463	<50	4.6	100
T.O. 7	270	172	4.8	100
T.O. 8	420	54	4.0	85

Table IV

Paper Machine Oils (Commercially Available) 500-700 SUS

Oil	S.E. No.	Herschel Demuls. at 130° F.	DDT at 130° F. % Water at Top	DDT at 130° F. % Water at Bottom
P.M. 1	1200	750	4.2	80
P.M. 2	1200+	<50	28	45
P.M. 3	1020	<50	31	65
P.M. 4*	630	300	6	100
			DDT at 180° F.	
P.M. 1	1200	750	4.0	70
P.M. 4*	630	300	5.6	100
P.M. 5	1200+	<50	4.0	50
P.M. 6	1020	<50	3.6	77

*Experimental formula.

for the 150 and 550 SUS oils were obtained at 80° and 130° F., respectively. It should be noted there is no apparent correlation between the values designated as "% Water at Top" and "% Water at Bottom". In the scores of runs made, no correlation has been found between these values and they have been used as individual data. The "% Water at Top" value has some significance in terms of impaired lubrication due to the presence of water in the oil. "% Water at Bottom" has significance in respect to oil loss from the system due to necessary water drainage.

On the basis of Steam Emulsion Number, the 150 Viscosity MCSR oil would be rated as having the best demulsibility properties. Considering the Herschel data, the 150 Viscosity Pennsylvania oil rates best. By the DDT, the 150 Viscosity MCSR rates best.

In the case of the 550 SUS oils, the MCCR oil rates best by the DDT and the Steam Emulsion Number Method. It is interesting that all oils had approximately equivalent Herschel values, but were effectively separated by the DDT in regard to demulsibility characteristics.

The data show some degree of correlation between the Steam Emulsion Number Method and the DDT for base oils (non-additive).

Turbine Oils

Table II presents demulsibility data for 150 SUS turbine oils as measured by the Steam Emulsion Number,

Table V

Experimental Paper Machine Oils, 500-700 SUS

Oil	DDT at 130° F. % Water at Top	DDT at 130° F. % Water at Bottom
A	14	85
B	10	90
C	12	85
D	16	75
E	14	100
F	12	90
G	24	95
P.M. 4	6	100
Base Oil	3.2	97

Table VI

Experimental Paper Machine Oils, 500-700 SUS

Oil	DDT % Water at Top 130° F.	DDT % Water at Top 180° F.	DDT % Water at Bottom 130° F.	DDT % Water at Bottom 180° F.
D	16	4.0	75	98
E	14	7.0	100	100
F	12	4.0	90	99
P.M. 4	6	5.6	100	100

Table VII

Additive Depletion at 180° F.
Paper Machine Oils, 500-700 SUS

Oil	DDT % Water at Top	DDT % Water at Bottom	% Additive Depletion
P.M. 1	4	70	86
P.M. 5	4	50	47
P.M. 6	3.6	77	42
P.M. 4	5.6	100	23

Note: Above oils are the same that appear in Table IV.

Table VIII

Repeatability Data
Additive Oils, 500-700 SUS

DDT at 130° F.			
Oil A		Oil B	
% Water at Top	% Water at Bottom	% Water at Top	% Water at Bottom
11.5	81	10.0	96
13.5	82	10.0	96
14.0	80	9.5	97
12.0	82	10.5	94
13.0	82	12.0	96
12.8 Avg.	81.5 Avg.	10.4 Avg.	95.8 Avg.

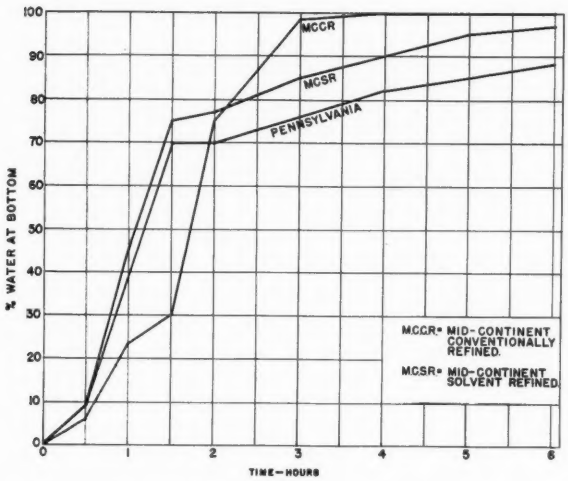


Figure 2. 550 SUS Base Oils @ 130° F., % Water at Bottom.

Herschel, and Dynamic Demulsibility Methods. T.O.4 rates the best by both the Steam Emulsion Number and the Herschel Method. However, T.O.1. and T.O.2. are the best on water separation characteristics as indicated by 100% "Water at Bottom". When both "% Water at Top" and "% Water at Bottom" are considered, T.O.2 would be considered the best.

Table III shows the same type of data for 450 SUS turbine oils which are compounded to meet the levels of performance required for M.S. 2190T oils.[4] Based upon the Steam Emulsion Number and Herschel value, T.O.6 would be expected to be the poorest of the four oils in demulsibility. However, its demulsibility characteristics as measured under dynamic conditions are as good as those of T.O.7, the oil with the better Steam Emulsion Number and Herschel value.

Paper Machine Oils

Demulsibility data are presented in Table IV for paper machine oils. Oils 1, 2, 3, 5, and 6 are commercially available, and Oil 4 is an experimental formula. The Steam Emulsion Numbers of Oils 1, 2, 3, 5, and 6 indicate that these oils have approximately equivalent demulsibility characteristics, while the Herschel values indicate that Oil 1 is better than Oils 2, 3, 5, and 6 in this respect. Although Oils 2, 3, 5, and 6 have equivalent demulsibility properties as measured by the Herschel Method, Oil 3 is better than Oil 2 at 130° F. by the DDT, and Oil 6 is better than Oil 5 by the DDT at 180°F. By the Dynamic Method, Oil 1 rates the best of the commercial oils at 130°F., and second best at 180°F. The relative order of demulsibility of the commercially available oils, under the conditions of plant operation, could not have been predicted by the conventional test methods. However, the order of results obtained by the Dynamic Demulsibility Test was in agreement with that observed in the field.

Consideration of the data obtained at 130 to 180°F. for Oil 1 reveals that in some cases an increase in test temperature does not necessarily improve the demulsibility characteristics of an oil.

Your attention is called to the data for Oil 4, an experimental paper machine oil which contains rust and oxidation inhibitors, a metallic dispersant, and an E.P. additive. Despite the heavy additive treatment, its demulsibility characteristics are very good.

The effects of additives upon demulsibility characteristics are illustrated in Table V. All of these paper machine oils were compounded using different additive materials, to have approximately the same level of performance with respect to rust and oxidation inhibition and detergency. It is obvious that the dynamic demulsibility characteristics were considerably affected by the different additives.

The data in Table VI reveal that in many cases demulsibility can be improved with an increase in temperature (decrease in viscosity). It is also apparent that an oil can be formulated to have good demulsibility characteristics over a range of 130 to 180°F., as illustrated by Oil 4.

The Dynamic Demulsibility Test can also be used to obtain data other than demulsibility data which are significant not only to the oil chemist but also to the consumer. In Table VII the data for "% Additive Depletion" clearly illustrate this.

These oils had been compounded to have high levels of rust and oxidation inhibition, detergency, and load-carrying capacity. Under the conditions of the DDT, Oils 1, 5, and 6, commercially available paper machine oils, lose upward of 42% of the additive as a direct result of water leaching. The additive depletion of Oil 4, an experimental oil, was only 23%.

The effect of water leaching of the rust inhibitor in turbine and hydraulic oils could be determined by conducting rust tests on the oils before and after the DDT.

Rate of Water Separation

In Figure 2, data for "% Water at Bottom" are plotted against test time for three oils evaluated at 130°F. The shapes of the curves reveal that differences exist in regard to rate of water separation and the time interval required to reach equilibrium.

In Figure 3, equivalent data are presented for a MCSR oil at both 130 and 180°F. These data illustrate that at the higher temperature the rate of water separation is greater, and the oil exhibits better demulsibility characteristics.

Table VIII presents repeatability data for two additive oils. It is felt that the degree of repeatability is satisfactory for a test of this type.

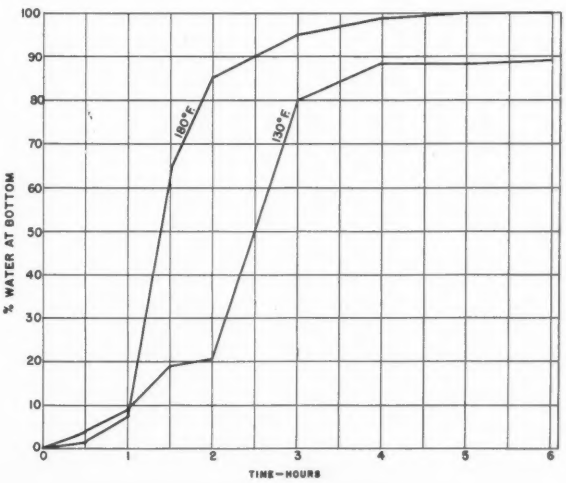


Figure 3. 550 SUS Mid-Continent Solvent Refined Base Oil @ 180 & 130° F., % Water at Bottom.

SUMMARY

The Dynamic Demulsibility Apparatus permits the measurement of the demulsibility characteristics of lubricants under conditions similar to those found in industrial circulating systems. Thus, it is of value to the consumer and the oil technologist. It also permits the oil technologist to differentiate readily between additive oils having demulsibility values outside the limited end points of the Herschel and Steam Emulsion Number Methods. As a secondary aid to research, it permits the evaluation of the resistance of additives to water leaching.

BIBLIOGRAPHY

1. *The Significance of ASTM Tests,* 3rd Edition, ASTM D-2.
2. *ASTM Standards on Petroleum Products & Lubricants,* 1954, ASTM D-2.
3. Brennan, E. W., "Hydraulic Oils," ASLE Chicago Section Meeting, May 1955.
4. Military Specification MIL-L-17331 (SHIPS), Sept. 30, 1952.

COMMENTARY

DR. G. H. VONFUCHS

The importance of the demulsibility characteristics of circulating oils is fully appreciated by anyone concerned with their service performance. There is also complete agreement that the results obtained with standard emulsion tests do not correlate with the known field performance of oxidation and rust inhibited turbine oils. The "Steam Emulsion Test of Lubricating Oils," the only ASTM demulsibility test, was such a hindrance to the development of the new inhibited turbine oils that about 10 years ago a footnote was added to the scope of D 157 - 36 disclaiming "any correlation to emulsion in service" of such oils. More recently (1951) the S.E. test was demoted to the status of tentative until such time that it could be replaced by a more suitable test. Under the chairmanship of Mr. M. D. Baker, chief chemist of the West Penn Power Company, the ASTM emulsion test committee (D-2 C IV) has been working on this problem and in the 1954 edition of the ASTM D-2 book published a method based on the Herschel test. (Federal specification VV-L-791e Method 3201.5) A modification of this method is now proposed as a tentative standard and on adoption by ASTM will automatically replace the S.E. test. The authors could greatly contribute to the cause if they would make available some of their oils for cooperative testing. Of particular value would be those circulating oils on which they also possess service records.

The authors should be congratulated on the approach they have taken in developing their Dynamic Demulsibility Test. The "Water on Top" and "Water at Bottom" measurements, and their recognition of the fact that some additives may be removed by water, are significant observations not only from a theoretical but also from a practical viewpoint. In the description of their test method, the type of water used in the test is not specified. However, it may be assumed that distilled water is used. Otherwise the results may conceivably be affected by the hardness and/or the alkalinity of the water. In practice, all types of water are encountered, and tests with water of known composition would be of interest. Additive removal could be significantly affected by certain constituents of the water with which the oil may come in contact.

Incidentally, in Table VII per cent additive depletions are given. Could the authors describe the method or methods used by them in determining these figures?

Additional information on the properties of the test oils such as IFT, neutralization value, specific gravity, ash content if any, and viscosity as well as viscosity index and also the service performance of the oils, as far as available, would be of interest.

The Dynamic Demulsibility Test described by the authors appears quite promising as a development tool for inhibited circulating oils. In this respect it would be advisable to have a more detailed test procedure particularly with regard to the precaution taken for cleaning the equipment in order to prevent carryover from one test to the next. The authors' estimate of the cost of their apparatus would also be of value.

AUTHORS' CLOSURE

We wish to thank Dr. von Fuchs for his kind remarks. We appreciate that the apparatus permits many investigations of both practical and theoretical significance; however, the data presented today is representative only of that available last Fall. Since that time we have been conducting tests, using the commercial apparatus, on 48 different steam turbine oil compositions. The accumulated data include IFT values, additive depletion in terms of reduced anti-rust and anti-oxidant performance levels, and demulsibility values. It is expected that a presentation will be made at the Fall Meeting of the ASTM D-2 Committee. The demulsibility characteristics of a few used steam turbine oils as measured by the DDT will also be reported.

In answer to Dr. von Fuchs' question concerning the method of determining additive depletion, the additives used in the paper machine oil were ash-containing. To determine the extent of additive depletion, ash as sulfate determinations were made on the oils before and after the Dynamic Demulsibility Test.

All tests were conducted with normal distilled water. The test procedure is not involved and is quite simple to follow, especially with the commercial model of the apparatus. As we said earlier, the apparatus is available from Labline, Inc., of Chicago. The unit is flushed with rubber solvent, followed by a flush with the test oil, to eliminate contamination with the previously tested sample.

COMMENTARY

C. A. BAILEY, U. S. STEEL CORP.

The Brennan-Moyer contribution of test procedure evaluating the dynamic demulsibility characteristics of oil is a very practical approach to steel mill circulating system problems. There is an urgent need for standard procedures for the evaluation of this property. The method should take its place along with the many procedures that have been considered and investigated through A.S.T.M. cooperative testing.

The paper does not mention the present Federal Method which has been under consideration by the A.S.T.M. Emulsion Committee for several years. Our experience confirms the authors' findings in several respects. A brief comparison of the Dynamic Demulsibility Method and the U. S. Steel Method, which is a modification of the Federal Method, may be of interest.

We have always experienced difficulty with the Herschel Test Method. A similar approach was made by determining the residual moisture in the oil after the Herschel number was taken. The results of several hundred of these tests indicated that a 1620 Herschel number could show a high residual moisture, while a 1000 Herschel number could have a low residual moisture. This phenomenon is confirmed by the Dynamic Demulsibility Method.

Thereafter we abandoned the Herschel Method and adopted the Federal Method which uses equal parts of oil and water in the Herschel apparatus. Our modifications were the slow addition of water and reporting oil, water, and emulsion values during a one-hour period.

We agree with the Dynamic Demulsibility Method that the dribbling of the water into oil is important, but we also like the reported values to reveal the action of the oil during the one-hour period.

In conclusion, the Dynamic Demulsibility Method appears to have the following outstanding advantages not found in any of the present methods: a larger volume of oil, and the leaching action to indicate additive depletion. The Dynamic Demulsibility Method deserves continued work between laboratories. When several units of the apparatus are in existence, studies can be made including the higher viscosity oils used in the steel industry.

AUTHORS' CLOSURE

We wish to thank Mr. Bailey for his complimentary remarks. We appreciate Mr. Bailey's interest in the demulsibility characteristics of oils in the viscosity range of 1000 SUS and higher. We have not evaluated oils of this type, but we do know the machine is mechanically capable of handling the oils.

As indicated in the foregoing graphs, samples can be taken progressively so as to determine the time required to reach equilibrium.

Disinfection of Soluble Oil Emulsions*

H. Pivnick & C. K. Fotopoulos
Department of Bacteriology
University of Nebraska
Lincoln, Nebraska

Soluble oils, more correctly called emulsifiable oils, are complex chemical mixtures. They may contain petroleum, lard oil, sperm oil, rape seed oil, tall oil, petroleum sulfonate, naphthenate, oleate, resinate, isopropopanol, and various glycol ethers. Some of them also contain disinfectants. Dispersed in water they readily support bacterial growth.[1-3]

The lowering of pH, breaking of the emulsion, production of foul odors, and staining of metals has been attributed to bacterial activity. Conclusive proof, however, of many of these allegations is not found in the scientific literature, and much work must be done before the role of bacteria in soluble oil spoilage can be understood.

Bacteria growing in soluble oil emulsions have been blamed for dermatitis.[4] But some scientists believe that this is not so. On the contrary, they believe that potential pathogenic bacteria, normally resident on the skin, invade the weakened or abraded epidermis and establish an infection.[5]

Control of bacteria in soluble oil emulsions has been attempted but appears, in most cases, to be inadequate. Pasteurization, the destruction of bacteria by heat, requires rather expensive installations which are suitable only for central systems. Furthermore, it has the disadvantage of leaving the system unprotected when the temperature is reduced. Bacteria which can contaminate the pasteurized emulsion will readily reach maximum population in 2 or 3 days.[6]

Chemical disinfection has the advantage of giving prolonged protection to the emulsion against microbial activity. Under actual operating conditions, however, numerous difficulties arise which reduce the benefits of chemical disinfectants. Most of these difficulties originate as a result of the lack of personnel who understand the complex nature of the problem and its many pitfalls. Some of these pitfalls are (1) the indiscriminate use of disinfectants which may be added in such large amounts that they irritate the skin or in such small amounts that they are useless, (2) the inactivation of disinfectants, (3) the selective growth of bacteria which are resistant to the disinfectant, (4) the effect of pH on distinfectant activity, (5) the effect of the type of oil on the efficiency of the disinfectant, and (6) the effect of cleaning the coolant system before disinfection. Obviously, adequate chemical disinfection is neither easy nor simple.

A survey of soluble oil manufacturers was carried out to determine their policy with respect to disinfection of

*This investigation was supported by a research grant (RG-4266) from the National Institutes of Health, Public Health Service.

H. Pivnick

C. K. Fotopoulos

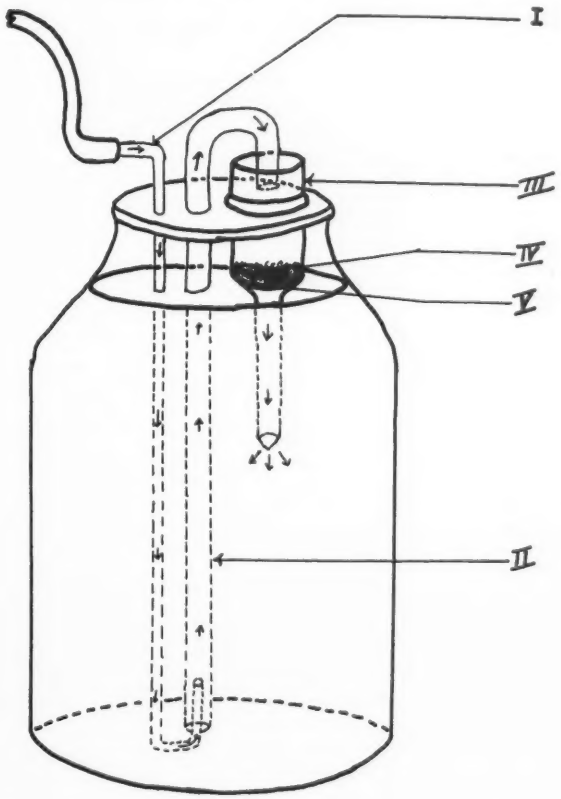


Figure 1. Apparatus for the circulation test. The gallon jar contains 3 liters of emulsion. Compressed air entering tube I forces emulsion through tube II into funnel III. The emulsion passes through 2 gm. of iron chips, IV, supported by wire screen, V.

soluble oils. The replies to this survey indicated that there was no uniform policy. Some manufacturers advocated the addition of disinfectants to the oil at the time it was manufactured. Others believed that any disinfectant added by the manufacturer, which was useful when the oil was diluted 1:100, would be too concentrated when the oil was diluted 1:10. They advised addition of the disinfectant to the emulsion by the user. A third opinion was that disinfection is unnecessary if sanitation is adequate.

In order to investigate the usefulness of the present policies regarding disinfection, several experiments were carried out using oils containing disinfectants. Disinfectants recommended by suppliers of soluble oils for addition to the emulsions were also tested. The present research, although making no pretense for completeness, shows definitively that the addition of disinfectants by some manufacturers has serious limitations. It also shows that some disinfectants recommended for addition by the user may be useless in controlling bacterial growth.

Experiments designed to test the effect of adding disinfectant to the emulsion employed three different oils: Oil I was an emulsifiable product containing a vegetable oil derivative, Oil O was composed mainly of mineral oil emulsified with petroleum sulfonate, and Oil P was an emulsifiable mixture of mineral oil and lard oil. These oils were mixed with tap water in the ratio of 1:10 and 1:100, and the emulsions were adjusted to pH 7.5.

Table I lists the disinfectants added to emulsions. Some are recommended specifically for addition to soluble oil emulsions, others are not. Where definite concentrations have been recommended, these have generally been used. Where no recommendations were given by the manufacturer, the compounds (or mixture, including inert ingredients) were used in a concentration of 0.1 per cent or more.

Experiments designed to test the effect of disinfectants incorporated into the emulsions by the manufacturers used 5 different coolants supplied by 4 different manufacturers. The oils, with available descriptions, are listed in Table II. Each oil was diluted with tap water in the ratio of 1:10 and 1:100, and tested in the circulating apparatus (Figure 1).

The inoculum for all experiments consisted of bacteria in used oil emulsions obtained from 4 machine shops in Lincoln, Nebraska. In order to obtain large numbers of bacteria for inoculum without introducing large volumes of used emulsions into the test systems, the bacterial populations in the 4 samples were increased. This was accomplished by introducing a small amount of each sample into fresh emulsion containing 0.1 per cent ammonium phosphate. After 48 hours on a shaker at room temperature, the bacterial populations in the 4 emulsions were enumerated by the plate count method. Equal numbers of bacteria from each of the 4 emulsions were mixed and diluted in order to obtain 3.1×10^8 bacteria per ml. This mixture was added to all test systems to obtain 1×10^7 bacteria per ml. of fresh emulsion.

Bacterial populations were enumerated by the plate count method. Distilled water adjusted to pH 7.5 was used as a diluent, and nutrient agar (Difco) was employed as a plating medium. Petri dishes were incubated at 30° C. for 48 hours.

Table I

Disinfectants Added to Soluble Oil Emulsions at Time of Use

Disinfectant	Components		Per Cent Concentration	
			Recommended	Used*
DS-1**	Sodium salt of 2,2-methylene bis		0.083	0.083
	Sodium salt of ethylene diamine tetra acetic acid			
	Sodium salt of o-phenylphenol			
	Sodium salt of 4-chloro-2-phenyl-phenol			
	Sodium salt of 6-chloro-2-phenylphenol			
	Inert ingredients	70.6%		
DS-2**	Sodium salt of dimethyl dithio-carbamic acid	27.6%	——	0.1-0.5
	Sodium salt of 2-mercaptobenzothiazole	2.4%		
	Inert ingredients	70.0%		
DS-3	Unknown		——	0.1
DS-4	Glyoxal	30.0%	——	0.1-0.33
	Inert ingredients	70.0%		
DS-6	Unknown		——	0.1
DS-7	Unknown		——	0.1
DS-8	Orthophenylphenol		0.065	0.1
DS-9**	Sodium-o-phenylphenate	97.0%	0.1-0.15	0.1
	Inert ingredients	3.0%		
DS-10**	2,3,4,6 Tetrachlorophenol	92.0%	0.1	0.1
	Inert ingredients	8.0%		
DS-11	4 & 6-chloro-2-phenylphenol	85.0%	——	0.1
	Inert ingredients	15.0%		
DS-13**	O-benzyl-p-chlorophenol		0.1-2.0	0.1
DS-14	Bithionol, 2-2-thiobis		——	0.1
DS-15	Phenylmercuric oleate	30.0%	——	0.1
	Inert ingredients	70.0%		
DS-16	Phenylmercuric acetate	10.0%	——	0.1
	Potassium 2,4,6 trichlorophenate	50.0%		
	Inert ingredients	40.0%		
DS-17	Phenylmercuric acetate	10.0%	——	0.1
	Potassium orthophenylphenate	50.0%		
	Inert ingredients	40.0%		
DS-18	Unknown		——	0.1
DS-19	Phenylmercuric acetate	30.0%	——	0.1
	Inert ingredients	70.0%		
DS-20**	Silver	0.6%	0.003	0.1
	Copper	0.1%		
	Phenylmercuric acetate	9.0%		
	Inert ingredients	90.3%		

*The concentrations used include all components in the mixture.
**These disinfectants were recommended for addition to soluble oil emulsions.
—— No recommendations given.

MATERIALS & METHODS

Methods used in this laboratory for testing disinfectants have been designed to simulate industrial conditions as closely as possible. For example, the test system contained soluble oil, tap water, disinfectant, iron chips, and an inoculum of bacteria indigenous to soluble oil emulsions. This mixture was aerated about 8 hours per day for 5 days of

each week.

Two methods were used for investigating the value of disinfectants in soluble oil emulsions.

1. *The preliminary test* was designed primarily as a screening test. Cotton plugged test tubes, 2.5 cm. × 20 cm., contained 30 ml. of emulsion, 2 gm. of iron chips, and the disinfectant in concentrations shown in Table I. They were not sterilized. The tubes, at an angle of 45°, were shaken for one week at room temperature, and were then challenged with 1 ml. of inoculum which furnished 1×10^7 bacteria per ml. of emulsion. Shaking was resumed for 10 days, and plate counts were made at 1 and 10 days.

2. *The circulation test* was the same as that used by Pivnick and Fabian.[7] The emulsions, containing disinfectants, were circulated about 8 hours per day for one week. Sufficient inoculum was then added to obtain 1×10^7 bacteria per ml. and the circulation resumed five days a week for 4 weeks. Plate counts were made at 1, 2, 4, 7, 14, 21, and 28 days. Emulsions which were sterile at 7 days were re-inoculated at 9 days with sufficient inoculum to obtain 1×10^7 bacteria per ml. The apparatus employed is shown in Figure 1.

Table II

Composition of Soluble Coolants Containing Disinfectants Incorporated by the Manufacturers

aa — A heavy-duty emulsifying oil containing 10 per cent of sulfurized sperm oil, extreme-pressure stainless type additives, and an unknown germicide.

dd — This is not a conventional soluble oil. It contains polyalkylenes, glycols, and derivatives. It is thought to have a mild retarding effect.

ee — A soluble oil containing a fatty compound, a sulfur compound, and an unknown germicide.

ii — A soluble oil containing soap and soap-like emulsifiers and an unknown germicide.

oo — A soluble oil containing phenylmercuric acetate and phenol.

Table III

Effect of Addition of Disinfectants to Soluble Oil Emulsions*

Disinfectant	Per Cent	Oil I				Oil O				Oil P			
		1%		10%		1%		10%		1%		10%	
		1 day	10 days	1 day	10 days	1 day	10 days	1 day	10 days	1 day	10 days	1 day	10 days
Control		120	183	120	132	130	171	125	176	130	183	41	94
DS-1**	0.083	60	119	75	18	15	37	100	46	28	50	30	45
DS-2**	0.1	200	1	84	95	204	50	92	96	188	50	90	51
DS-13**	1.0	21	11	12	3	8	7	31	15	9	11	16	2
DS-4	0.1	0	0	180	42	0	0	0	0	0	0	600	75
DS-15	0.1	0	0	.002	0	0	0	0	0	0	.004	1.6	31
DS-16	0.1	0	0	0	0	0	0	0	0	0	0	1	6
DS-17	0.1	0	0	0	0	0	0	0	0	0	0	15	87
DS-18	0.1	206	193	100	200	91	55	200	146	245	196	350	26
DS-19	0.1	.0008	0	0	0	0	0	0	0	0	0	0	0

*All emulsions were inoculated with sufficient bacteria to obtain 10^7 cells per ml.
Figures shown × 10^6 = bacterial populations per ml. For composition of disinfectants and soluble oils see Table I and text respectively.
**Recommended for addition to soluble oil emulsions.

RESULTS

I. Disinfectants Added to the Emulsions.

The preliminary test. Table III shows the effect of varying oil concentrations on the efficiency of added disinfectants. For example, disinfectants DS-4, DS-16, and DS-17 showed limited or no effect in an emulsion containing 10 per cent of soluble Oil P, but they destroyed all bacteria in an emulsion containing 1 per cent of the same oil. Table III also shows that the type of oil may influence the effectiveness of the added disinfectants. For example, Oil P in 10 per cent concentration inhibited the activity of disinfectants DS-4, DS-15, DS-16 and DS-17, but Oil O in the same concentration did not prevent the disinfectants from killing all of the added bacteria. It may be significant that Oil P contained lard oil, while Oil O was composed mainly of mineral oil and petroleum sulfonate.

Table IV shows the effect of adding several disinfectants to an emulsion containing 1 per cent of Oil I. In this experiment, only disinfectant DS-20 sterilized the emulsion. Several of the compounds appeared to have limited activity, while disinfectants DS-3, DS-6, and DS-14 were useless. DS-7, DS-9, and DS-20 were subjected to the circulation test (Figure 3).

Table IV

Effect of Addition of Disinfectants to Emulsion Containing One Per Cent of Soluble Oil I*

Disinfectant	Per Cent	1 day	10 days
Control		22	17
DS-8**	0.1	1.2	2.4
DS-9**	0.1	10	1.9
DS-10**	0.1	0.8	1.0
DS-20**	0.1	0	0
DS-3	0.1	121	43
DS-6	0.1	9	14
DS-7	0.1	3.2	9
DS-11	0.1	8	3.8
DS-14	0.1	28	17

*All tests were inoculated with sufficient bacteria to obtain 10^7 cells per ml. Figures shown × 10^6 = bacterial population per ml. For composition of disinfectants and soluble oils see Table I and text respectively.
**Recommended for addition to soluble oil emulsions.

The circulation test. Several compounds which had been examined in the preliminary test were subjected to the circulation test using emulsions containing 1 and 10 per cent of Oil I. Disinfectants DS-1 and DS-2, although they appeared useless in the preliminary test, were examined in the circulation test because they were recommended for addition to soluble oil emulsions.

Figure 2 shows the effect of these compounds in

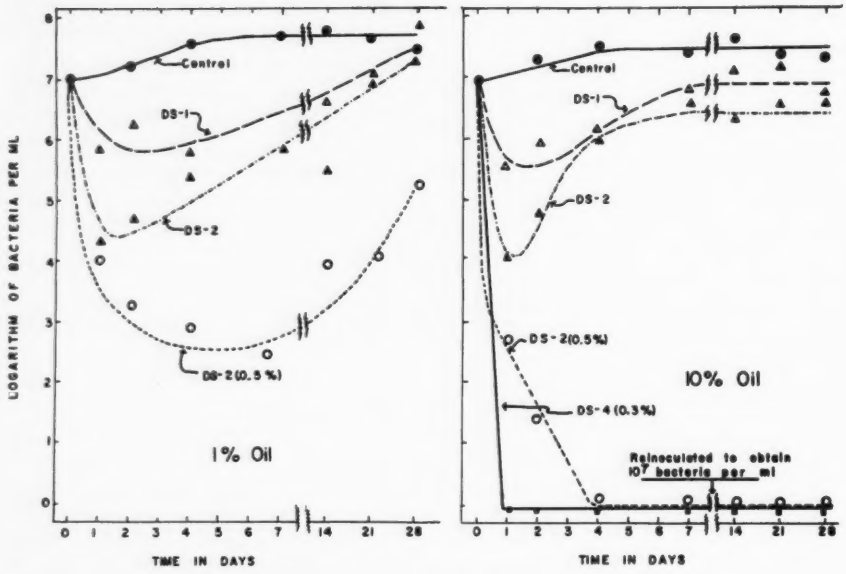


Figure 2. Effect of addition of disinfectants to emulsions containing 1 and 10 per cent of Oil I. Disinfectants in concentration of 0.1 per cent unless specified.

emulsions containing 1 and 10 per cent oil respectively. Apparently disinfectant DS-1 has little value in the concentration recommended, while disinfectant DS-2 has considerable activity in 0.5 per cent but not in 0.1 per cent concentration. It is interesting to note that disinfectant DS-2 in 0.5 per cent concentration is more effective in an emulsion containing 10 per cent than in one containing 1 per cent of Oil I. Disinfectant DS-4 (0.33 per cent solution of glyoxal = 0.1 per cent of pure glyoxal) is effective in an emulsion containing 10 per cent oil, and its disinfecting activity is maintained against reinoculation.

Figure 3 shows the effect of three other compounds examined under conditions similar to those used for work depicted in Figure 2. Disinfectants DS-20 and DS-9 were recommended for use in soluble oil emulsions, while disinfectant DS-7 appeared to be bactericidal in the preliminary test. Apparently their activity was not pronounced although, in emulsions containing 1 per cent oil, all disinfectants reduced the populations in the emulsions to a slight degree. It is interesting to note that DS-20 sterilized Oil I in the preliminary test, while DS-9 reduced the bacterial population considerably (Table IV). The circulatory test appears to reduce the effectiveness of the disinfectant.

II. Disinfectants Incorporated into the Oils by the Manufacturers.

Four soluble oils (aa, oo, ee, and ii) contained disinfectants added by the manufacturers. On compound (dd) is not a conventional soluble oil, but is a synthetic compound which is thought to have inhibitory activity towards bacteria. Figure 4 shows that when four of these compounds are diluted 1:100, they all support large bacterial populations; while Figure 5 shows that when diluted only 1:10, there is a transitory pronounced germicidal activity followed by a prolonged activity which decreases bacterial population slightly below those obtained in 1 per cent oil. Figure 6 shows dramatically that dilution of another compound, Oil oo, to 1:100 dilutes the disinfectant to the extent that it has little activity, but a dilution of 1:10 leaves a sufficient concentration of the disinfectant to sterilize the emulsion. When the emulsion was reinoculated at 9 days, however, the inoculum grew rapidly. Apparently the disinfectant was inactivated in the circulation test.

DISCUSSION

Testing of disinfectants in the laboratory should give an indication of their effectiveness under field conditions. For this reason any study of the disinfection of soluble oil emulsions should include aeration, the presence of metal chips, repeated inoculation with microbes indigenous to soluble oil emulsions, and variation of both type and concentration of the oil in the emulsion. It is felt that the

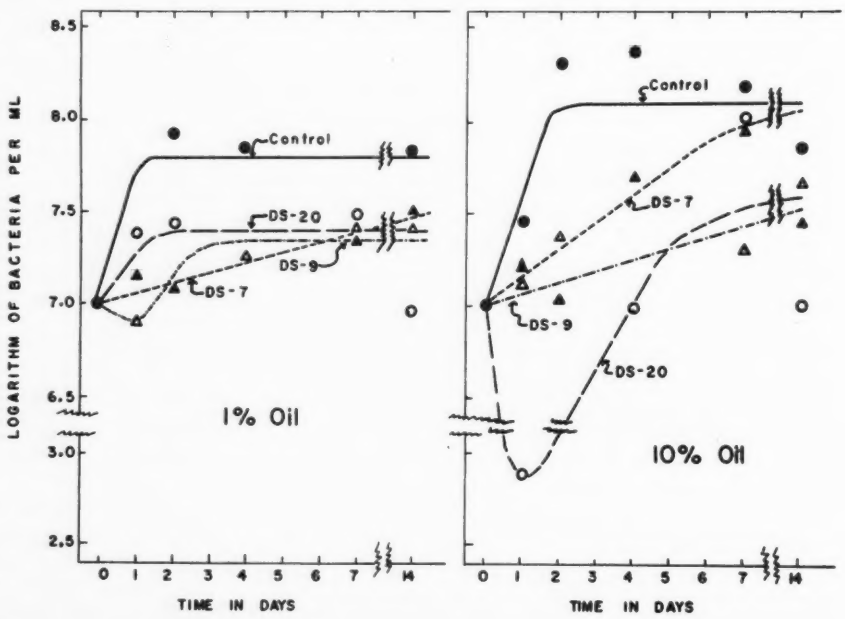


Figure 3. Effect of addition of disinfectants to emulsions containing 1 and 10 per cent of Oil I. Disinfectants in concentration of 0.1 per cent.

work reported in this paper has taken these factors into account.

Probably the apparatus shown in Figure 1 could be simplified without losing is effectiveness. For example, the apparatus for circulating the emulsion could be replaced by a simple aeration tube introduced into the emulsion, and the iron chips could rest on the bottom of the jar. Such an apparatus would require less trouble to set up and use.

This work was undertaken with the object of critically examining the viewpoints of the oil manufacturers with respect to disinfection. It realized this objective by adding to emulsions compounds recommended for disinfection of this material, and also testing oils containing disinfectants added by the manufacturer. No attempt was made to evaluate the idea of using sanitation without the addition of disinfectants, although this work will be carried out.

Many compounds recommended for addition to soluble oil emulsions appear useless for controlling bacterial growth under the conditions of these tests. It is possible, however, that such compounds may selectively inhibit certain types of spoilage bacteria while allowing less troublesome bacteria to grow. Some manufacturers of disinfectants have claimed that their materials are used primarily to control odor formation. To date no data appear in the scientific literature.

It is realized that the complete destruction of bacteria in soluble oil emulsions may be unnecessary to control spoilage. It would seem desirable, however, to reduce bacterial populations as much as possible in order to control spoilage if, as seems probable, spoilage is the result of bacterial activity.

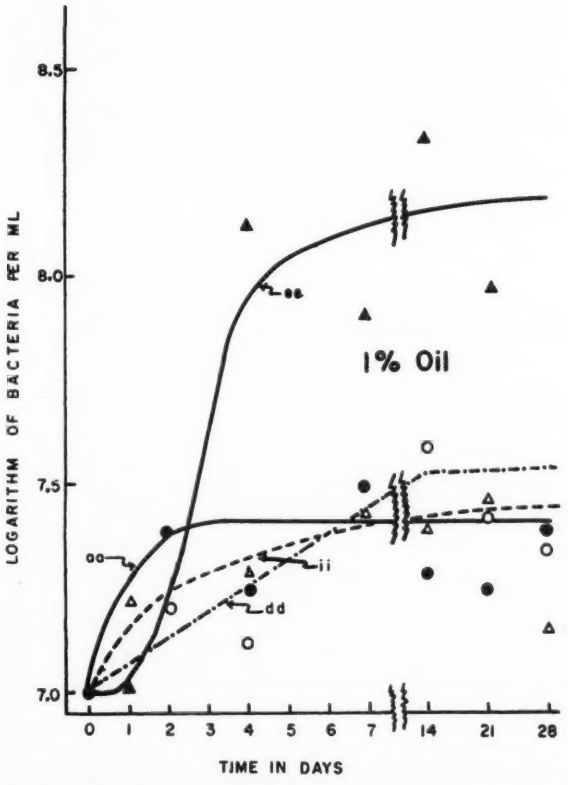


Figure 4. Growth of bacteria in 1 per cent emulsions containing disinfectants incorporated into the oils by the manufacturers.

Compounds recommended as disinfectants are seriously affected by the type and concentration of oil. This indi-

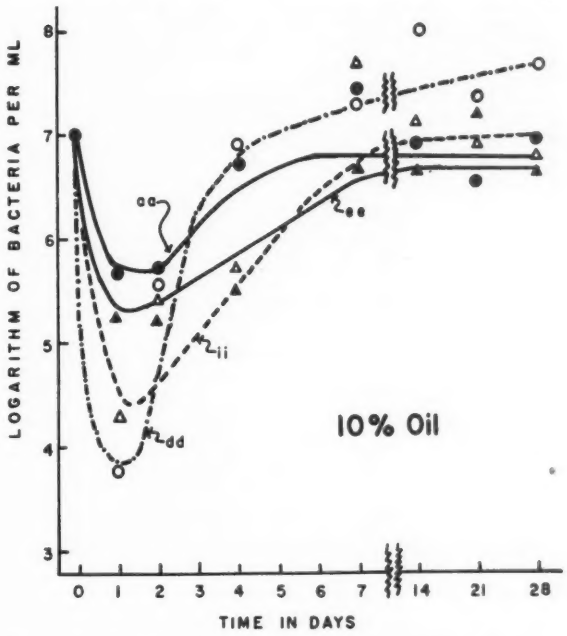


Figure 5. Growth of bacteria in 10 per cent emulsions containing disinfectants incorporated into the oils by the manufacturers.

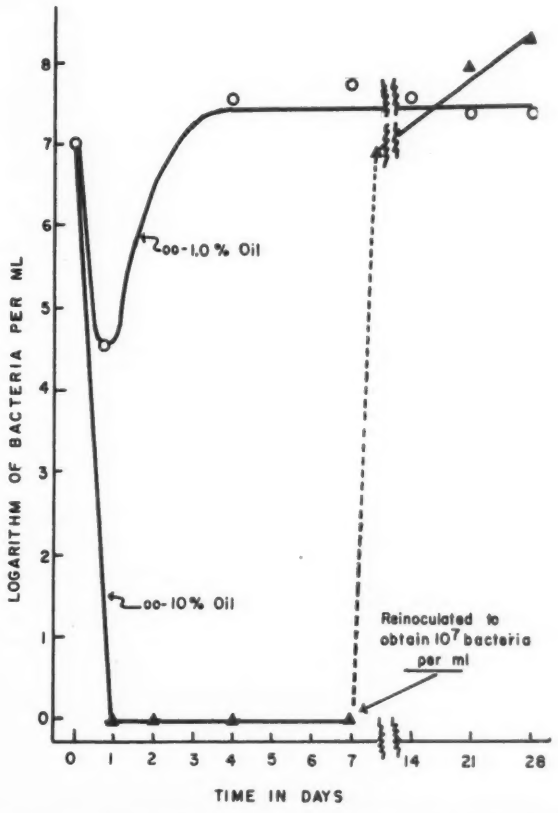


Figure 6. Effect of dilution and prolonged usage on the efficiency of a disinfectant incorporated into the oil by the manufacturer.

cates that any industrial use of disinfectants should be preceded by a study of their efficiency in the oil under conditions at least comparable to those in which the oil will be used.

The addition of disinfectants should also be concerned with the health of the workers as well as with the control of bacteria. For example, a report obtained from a large machinery manufacturer stated that they could obtain effective control of bacterial growth by using 0.25 per cent of a certain compound. Their medical department would not permit the use of this high concentration and, finally, because of dermatitis among the workers, the medical department stopped the use of this disinfectant completely. The manufacturers of the compound in question recommended that it be used in 0.1 to 0.15 per cent concentration in soluble oil emulsions.

The organic mercurial compounds appear to be fairly effective in controlling bacterial growth. Many manufacturers of soluble oils do not use them, however, because of the possibility of cumulative toxicity and allergic reactions. One manufacturer stated that such compounds were used in their oils at one time, but they had discontinued them because they lost their effectiveness. Mercurials have a history of causing allergic reactions, and a federal health agency with which we have corresponded has advocated against their use in soluble oil emulsions. If these compounds are used, it would be advisable to maintain close scrutiny for symptoms of mercury poisoning as well as allergic reactions.

Several compounds not previously recommended for use in soluble oil emulsions were examined. Of these, the aldehyde, glyoxal, may be of some value.

SUMMARY

The experiments reported in this paper, although limited in scope, clearly show that the current methods for controlling microbial growth in soluble oil emulsions leave much to be desired. It is our opinion that it will be difficult to find a single compound which will be useful under all circumstances, although mixtures of compounds or successive additions of different compounds, perhaps at monthly intervals, may be of some help.

At the present time relatively little is known about the activity of the bacteria in the emulsions; the effect of the disinfectants on the bacteria; and the various physical and chemical interactions among the bacteria, emulsions, and disinfectants. Until more knowledge of these aspects can be obtained, it is expected that many coolant spoilage problems will be insoluble.

One of the most essential prerequisites in any disinfection program is thorough cleaning. This is necessary for two reasons: (1) the residual dirt may inactivate disinfectants, and (2) the larger the number of bacteria available to contaminate a fresh emulsion, the greater the chance that some strains will be present which are resistant to the disinfectant in the emulsion. Unfortunately, this aspect of a disinfection program is frequently neglected.

In a discussion of the practical aspects of disinfection, Mallman[8] stated that the efficiency of disinfectants was impaired by organic matter, dirt, pH, neutralizing agents and, particularly, by incompetence of operators. Perhaps some of these factors are also responsible for failure of disinfectants in soluble oil emulsions.

BIBLIOGRAPHY

1. Page, C. C., & L. D. Bushnell, "Oil Folliculitis," *J. Ind. Hyg., Vol. 3,* 1926, p. 62.
2. Lee, M., & A. C. Chandler, "A Study of the Nature, Growth, and Control of Bacteria in Cutting Compounds," *J. Bact., Vol. 41,* 1941, p. 373.
3. Fabian, F. W., & H. Pivnick, "Growth of Bacteria in Soluble Oil Emulsions," *Appl. Microbiol., Vol. 1,* 1953, p. 199.
4. Shapiro, H., "Cutting Oil Dermatosis," New York State Dept. of Labor, *Monthly Rev., Vol. 29,* No. 2, 1950.
5. Schwartz, L., "Dermatitis from Cutting Oils," *Pub. Health Reports, Vol. 56,* 1941, p. 1947.
6. Weirich, C. L., "Health Hazards of Cutting Oils," *Safety Eng., Vol. 85,* 1943, p. 36.
7. Pivnick, H., & F. W. Fabian, "Methods for Testing the Germicidal Value of Chemical Compounds for Disinfecting Soluble Oil Emulsions," *Appl. Microbiol., Vol. 2,* 1954, p. 107.
8. Mallmann, W. L., "Practical Aspects of Disinfection," *Soap & Sanitary Chemicals,* March, 1948.

Current Literature

(The following reports of research for the Armed Forces have been recently released for industry use, and may be obtained at the prices indicated by writing: Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.)

Corrosion Resistance of Phosphated Steel After Heating Under Oil, by J. Doss, Rock Island Arsenal Lab., U. S. Army; Aug. 1955, 14 pages. Accelerated corrosion tests were performed on zinc and manganese phosphate coatings on steel to determine the effect of elevated temperatures in the absence of air on the corrosion resistance of the coatings. The coatings were heated under oil at 25° intervals in the range of 175 through 450° F. Zinc phosphate coatings began to lose corrosion resistance at a temperature between 300 and 325°; manganese phosphate coatings between 400 and 425°. (Order No. PB-111915, price 50¢)

Corrosion-Preventive Additives, by M. Feinleib & H. T. Francis, Armour Research Foundation for Wright Air Dev. Center, U. S. Air Force; July 1952, 22 pages. Certain fractions of petroleum sulfonates used as inhibitors in instrument oils were identified as causing corrosion where the oils were used as ball bearing preservatives. The report describes a reproducible test developed to determine corrosion-preventive characteristics of oils used with bearings with brass-to-steel and all-steel contacts. (Order No. PB-121072, price 75¢)

Research Study of Thixotropy of Greases, by A. C. Borg & R. H. Leet, Standard Oil Co. (Ind.) for Ordnance Corps, U. S. Army; Feb. 1956, 39 pages. This final report of research into the thixotropy of greases, or the changes in consistencies during and after shearing, deals with the effect of thickener particle dimensions (length-over-width ratio, or L/W) on laboratory and simulated service tests of a series of greases with the same soap concentration and consistency. Particle dimensions were measured after working and aging. Evaluation of relationships between fiber dimensions and grease properties showed that both mechanical stability and leakage tendency increased as L/W ratio increased, and that the most thixotropic greases had L/W ratios less than 15. (Order No. PB-121281, price $1)

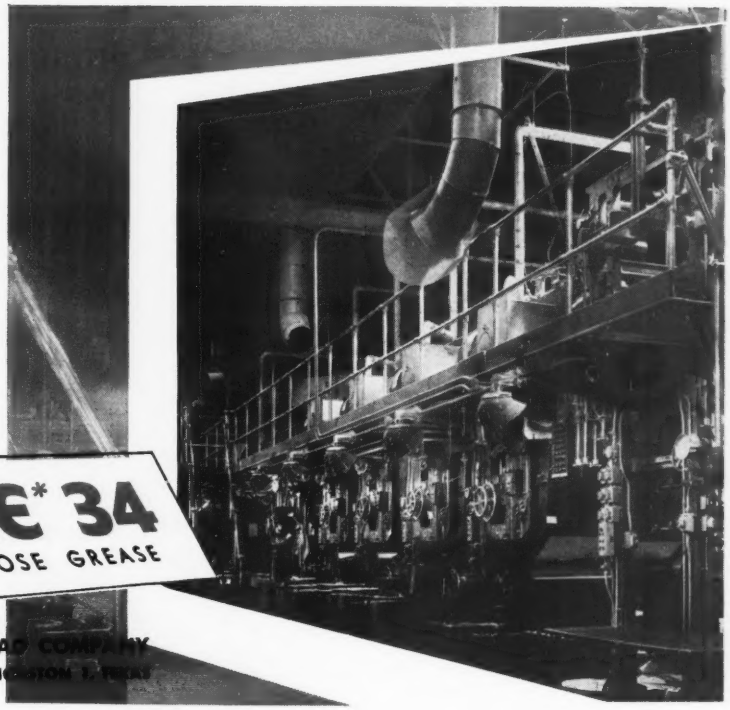
Micro Lubricant Test Methods, Vis-

(Continued on p. 164)

BENTONE* 34 based greases

resist leaching and cut costs

High-speed printing machinery poses a typical tough lubricating problem: what grease will stand up where the bearings are washed by solvents, thinners and leaching solutions? The Art Gravure Corporation of Cleveland, Ohio, standardized on grease made with Bentone* 34 and found that it stays in place, cuts maintenance cost, needs less frequent lubrication. Write for data and list of suppliers of grease made with non-soap, metal-adhesive Bentone 34.



Dutch Boy
* TRADEMARKS REGISTERED

BENTONE* 34
FOR MULTI-PURPOSE GREASE

BAROID DIVISION • NATIONAL LEAD COMPANY
5732 P. O. BOX 1675 HOUSTON 1, TEXAS

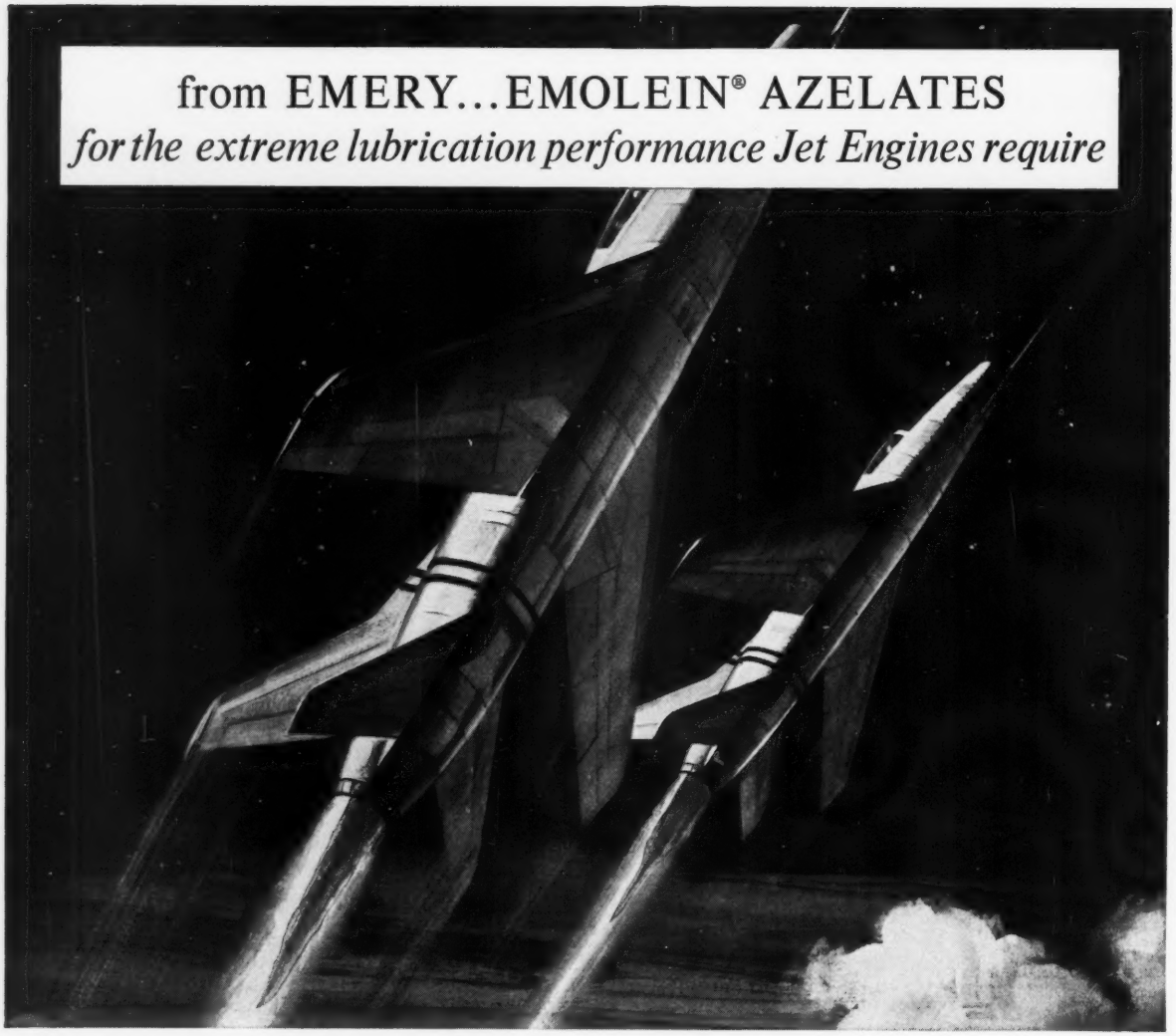
BENTONE* 34
Grease Manufacturers and Distributors

THE ACME REFINING CO., Cleveland, Ohio
ADAM COOKS SONS, INC., Linden, N. J.
ALEMITE DIV., STEWART-WARNER CORP., Chicago, Ill.
ALLUBE CORP., Glendale, Calif.
THE AMERICAN LUBRICANTS CO., Dayton, Ohio
ARKANSAS FUEL OIL CORP., Shreveport, La.
BATTENFELD GREASE & OIL CORP., Kansas City, Mo.
BATTENFELD GREASE & OIL CORP. OF CALIFORNIA, Compton, Calif.
BATTENFELD GREASE & OIL CORP. OF NEW YORK, North Tonawanda, N. Y.
BEL-RAY CO., INC., Madison, N. J.
BOBBISH INDUSTRIAL PRODUCTS CO., Dearborn, Mich.
THE BROOKS OIL CO., Pittsburgh, Pa.
CASCADE PETROLEUM CO., Denver, Colo.
CATO OIL AND GREASE CO., Okla. City, Okla.
CONSUMERS COOPERATIVE ASSOCIATION, Kansas City, Mo.
CRAWFORD EMULSIONS, Pittsburgh, Pa.
DENS-OIL LUBRICANT CO., Kansas City, Mo.
JAMES W. DOYLE CORP., Detroit, Mich.
FISKE BROTHERS REFINING CO., Newark, N. J.
FISKE BROTHERS REFINING CO., Toledo, Ohio
THE FRANKLIN OIL AND GAS CO., Bedford, O.
GEORGIA-CAROLINA OIL CO., Macon, Georgia
GLOBE GREASE & MFG. CO., Los Angeles, Calif.
GOPLERUD LUBRICANTS CO., Mason City, Iowa
GREDAG, INC., Niagara Falls, N. Y.
HI-WAY REFINERIES, LTD., Regina, Sask., Canada
THE HODSON CORP., Chicago, Ill.
THE HODSON CORP. (QUEBEC), INC., Three Rivers, Quebec, Canada
E. F. HOUGHTON & CO., Philadelphia, Pa.
ILLICO INDEPENDENT OIL CO., Lincoln, Ill.
INTER-STATE OIL CO., Kansas City, Kansas
KEYSTONE LUBRICATING CO., Philadelphia, Pa.
LUBRICATION CO. OF AMERICA, Los Angeles, Calif.
MacMILLAN OIL CO. OF ALLENTOWN, Allentown, Pa.
MAGIE BROTHERS, INC., Chicago, Ill.
MAGNUS CHEMICAL CO., Garwood, N. J.
MANITOBA CO-OPERATIVE WHOLESALE LTD., Winnipeg, Man., Canada
METALCOTE OIL CO., St. Paul, Minn.
MID-STATES LUBRICANTS, Kansas City, Mo.
MIDWEST OIL CO., Minneapolis, Minn.
THE OHIO GREASE COMPANY, Loudonville, O.
OIL-KRAFT, INC., Cincinnati, O.
OIL DISTRIBUTORS OF PHILADELPHIA, Philadelphia, Pa.
ONYX INTERNATIONAL, Jersey City, N. J.
PANTHER OIL & GREASE MFG. CO., Fort Worth, Texas
PANTHER OIL & GREASE MFG. CO. OF CANADA, Toronto, Ontario, Canada
PENN-CREST OIL & GREASE CORP., Long Island City, N. Y.
PENN PRODUCTS CO., DuBois, Pa.
PHOENIX OIL COMPANY, Augusta, Ga.
A. B. PLATING SUPPLY CO., Milwaukee, Wisc.
PRAIRIE STATES OIL & GREASE CO., Danville, Ill.
PRECISION BEARING & TRANSMISSION CO., Omaha, Nebr.
RILEY BROS., INC., Burlington, Iowa
THE SAHARA OIL CO., DuQuoin, Ill.
SASKATCHEWAN FEDERATED COOP. LTD., Regina, Sask., Canada
ADOLF SCHMIDS ERBEN S. A., Bern, Switzerland
SERVICE LUBRICANTS, INC., Chicago, Ill.
L. SONNEBORN SONS, INC., New York, N. Y.
SOUTHWEST GREASE & OIL CO., INC., Wichita, Kan.
SOUTHWESTERN PETROLEUM CO., Fort Worth, Texas
SPECIALTY PRODUCTS CO., Jersey City, N. J.
SUNLAND REFINING CORP., Fresno, Calif.
SYRACUSE FIRE BRICK SUPPLY, Syracuse, N. Y.
THREE RIVERS REFINERY, Three Rivers, Tex.
TIDE WATER ASSOCIATED OIL CO., N. Y. C.
TIONA PETROLEUM CO., Philadelphia, Pa.
TOPSALL LUBRICANTS, INC., Kenmore, N. Y.
TOWER OIL CO., Chicago, Ill.
TRANSMISSION EQUIPMENT CO., Pittsburgh, Pa.
TRI-STATE PETROLEUM CO., Philadelphia, Pa.
UNITED COOPERATIVES, INC., Alliance, Ohio
UNITED PETROLEUM CORPORATION, Omaha, Nebraska
UNIVERSAL AVIATION SUPPLY, Wichita, Kan.
G. C. WAKEFIELD & CO., LTD., Toronto, Ontario, Canada
THE WARREN REFINING AND CHEMICAL CO., Cleveland, Ohio
THE WAVERLY OIL WORKS CO., Pittsburgh, Pa.
WESTLAND OIL CO., Minot, N. D.

*T.M. Reg.

BENTONE·34®

from EMERY...EMOLEIN® AZELATES
for the extreme lubrication performance Jet Engines require



MEETS BOTH MILITARY AND CIVILIAN REQUIREMENTS

Synthetic lubricant fluids that meet both military (Mil-L-7808-C) and civilian specifications are now being compounded from Emolein Azelates (diesters).

The excellent performance of these new diesters, Emolein 2957 di-iso-octyl azelate and 2958 di-2-ethylhexyl azelate in lubricants designed to meet the extreme heat and cold performance qualities required by jet engines, is attributed to the following combination of properties:

1) excellent temperature-viscosity performance even at high and low temperature extremes... 2) high viscosity index... 3) low pour points... 4) excellent lubricity... 5) oxidation and corrosion stability... 6) high flash and fire points... 7) excellent additive response.

Produced from non-strategic raw materials

Since the Emolein azelates are based on azelaic acid obtained from domestic fats and oils abundant in supply, availability is not contingent on strategic imported raw materials. Also, future plant expansion is being carefully coordinated with the broadening utility of these diesters.

Application in other synthetic lubricants

Other military specifications met by synthetic fluids and greases compounded from Emolein Azelates include: Mil-G-3278 A, Grease, Aircraft and Instruments-Low and High Temperatures; Mil-L-6085 A, Lubricating Oil, Aircraft Instruments, Low Volatility; and Mil-L-6387 A, Lubricating Oil, Synthetic Base.

Mail coupon below for full technical information.

Emery **Organic Chemical Sales Department**

Emery Industries, Inc., Carew Tower, Cincinnati 2, Ohio

Emery Industries, Inc., Dept. LE-3, Carew Tower
Cincinnati 2, Ohio

Please send me a copy of your 16-page Technical Bulletin No. 409 titled "Emolein Esters for Synthetic Lubricants."

Name.....Title.....

Company.....

Address.....

City.....State.....

Coming Events

MARCH 15-17, Society of Women Engineers (Annual Convention), Houston, Tex.

18 & 19, Steel Founders' Society of America (55th Annual Meeting), Drake Hotel, Chicago, Ill.

18-21, American Society of Mechanical Engineers (Gas Turbine Power Conference), Sheraton-Cadillac Hotel, Detroit, Mich.

18-21, Institute of Radio Engineers (National Convention), Waldorf-Astoria Hotel and the Coliseum, New York City.

18-21, Military Automation Exposition, Trade Show Bldg., New York City.

18-21, Society of the Plastics Industry (Annual National Conference), Biltmore Hotel, Los Angeles, Calif.; 18-21, Pacific Coast Plastics Exposition, Shrine Exposition Hall, Los Angeles.

20-22, American Petroleum Institute, Div. of Production (Southern District Meeting), Washington Youree & Captain Shreve Hotels, Shreveport, La.

20-22, Society of Automotive Engineers (Production Meeting & Forum), Statler Hotel, Buffalo, N. Y.

21-23, American Physical Society (Regional Meeting), Philadelphia, Pa.

23-27, American Society of Tool Engineers (25th Technical Meeting & Convention), Shamrock Hilton Hotel, Houston, Tex.

25-29, American Society for Metals (Western Metal Congress & Exposition), Pan-Pacific Auditorium, Los Angeles, Calif.

27-28, AIEE-ASME Engineering Management Conference, William Penn Hotel, Pittsburgh, Pa.

27-29, American Power Conference, Hotel Sherman, Chicago, Ill.

28, National Industrial Conference Board (General Session), Sheraton-Palace Hotel, San Francisco, Calif.

28-29, American Institute of Electrical Engineers (Paper & Pump Conference), Georgia Institute of Technology Campus, Atlanta, Ga.

28-30, Ohio Society of Professional Engineers (Annual Meeting), Neil House, Columbus, Ohio.

APRIL 1-2, Industrial Engineering Conference, Purdue University Campus, West Lafayette, Ind.

2-5, Society of Automotive Engineers (Aeronautic Meeting, Aeronautic Production Forum & Aircraft Engineering Display), Hotel Commodore, New York City.

3-5, American Rocket Society (Spring Meeting), Washington, D. C.

5-6, American Society for Engineering Education (Southeastern Section Meeting), Brown Hotel, Louisville, Ky.

7-10, American Society of Mechanical Engineers (Instruments & Regulators Conference), Northwestern University Campus, Chicago, Ill.

7-12, American Chemical Society (131st National Meeting), Miami, Fla.

8-9, American Institute of Electrical Engineers (Rubber & Plastics Conference), Akron, Ohio.

8-10, American Institute of Mining, Metallurgical & Petroleum Engineers (Open Hearth & Blast Furnace Conference), William Penn Hotel, Pittsburgh, Pa.

8-10, American Society of Mechanical Engineers (Spring Meeting), Dinkler-Tutwiler Hotel, Birmingham, Ala.

8-11, American Management Association (Annual national Packaging Exposition), International Amphitheatre, Chicago, Ill.

8-11, National Electrical Industries Show, 71st Regiment Armory, New York City.

8-12, American Welding Society (National Spring Meeting), Hotel Sheraton, Philadelphia, Pa.; 9-11, Fifth Welding Show, Convention Hall, Phila.

9-10, Conference on Electronics in Industry, Illinois Institute of Technology Campus, Chicago, Ill.

9-11, The Canadian Institute of Mining & Metallurgy (Annual General Meeting), Quebec City, Que., Canada.

10-12, American Petroleum Institute, Div. of Production (Mid-Continent District Meeting), Mayo Hotel, Tulsa, Okla.

10-12, Instrument Society of America (National Nuclear Instrumentation Conference & Southeastern Regional Conference & Exhibit), Biltmore Hotel, Atlanta, Ga.

11-13, Illinois Society of Professional Engineers (Annual Meeting), Sherman Hotel, Chicago, Ill.

11-13, Institute of Radio Engineers (National Simulation Conference & Southwest Regional Conference), Shamrock Hilton Hotel, Houston, Tex.

15-17, American Society of Lubrication Engineers (12th Annual Meeting & Exhibit), Sheraton-Cadillac Hotel, Detroit, Mich.

ASLE

12th Annual Meeting & Exhibit

April 15-16-17 **Detroit, Mich.**

NEW...
EMERY 3033-S
LUBRICANT ESTER...

a new-type diester base for synthetic lubricants

Emery 3033-S is a new-type dipropylene glycol diester based on pelargonic acid, a unique, C_9, saturated, monobasic acid.

It is currently in use or under test in the following three areas: 1) Synthetic greases for spec. Mil-G-3278-A Low Temperature Aircraft Grease; 2) Low-cost blending component for synthetic low-temperature lubricating fluids meeting Mil-L-7808 C; and 3) synthetic lubricant base fluid for civilian lubricants in aircraft, automotive and specialty uses.

Since 3033-S is based on a relatively low-cost acid, pelargonic acid, long-range economics are favorable. Also, availability is not contingent on strategic, imported raw materials since pelargonic acid is made from abundantly available domestic fats and oils.

Though 3033-S is in a development stage, it is available in tankcar quantities on reasonable notice.

Mail coupon below for Technical Bulletin titled "Emery 3033-S Lubricant Ester" for complete characteristics and performance data in synthetic greases and fluids.

Emery

Development and Service Department
Emery Industries, Inc.
Carew Tower, Cincinnati 2, Ohio

Emery Industries, Inc.
Dept. LE-3A, Carew Tower
Cincinnati 2, Ohio
Please send Development Product Bulletin #60 on Emery 3033-S.

Name.....
Company.....
Address.....
City.....State.....

Patent Abstracts

(Compiled by Ann Burchick, Aluminum Co. of America.)

Non-Inflammable Hydraulic Fluid, Patent No. 2,737,497 (J. I. Wasson & A. J. Morway, asignors to Esso Research & Engrg. Co.) A substantially non-inflammable hydraulic fluid comprising from 40 wt. percent to 65 wt. percent of water, and from 9 wt. percent to 34 wt. percent of ethylene glycol as a water-glycol base, from about 5 wt. percent to 40 wt. percent of a polymeric thickener selected from the group consisting of polyalkylene glycols having viscosities of from about 400 to about 200,000 S.U.S. at 100 F., and about 0.5 wt. percent to 2.0 wt. percent of an alkali metal soap of a polybasic aliphatic acid which is soluble in said water-glycol base, said acid being substantially a dimer of an unsaturated fatty acid having from 12-22 carbon atoms per molecule.

Anti-Static Rayon Oils, Patent No. 2,738,324 (J. M. Hood, assignor to American Cyanamid Co.) An antistatic and lubricating agent for treating yars, filaments and fibers to render them more amenable to textile operations and to eliminate their tendency to accumulate charges of static electricity comprising from about 7.5% to about 15% by weight of dodecyl toluene sodium sulfonate; from about 7.5% to about 15% by weight of a member of the group consisting of the sodium salt of a branched chain didecyl sulfosuccinate, the ammonium salt of a branched chain didecyl sulfosuccinate, the ammonium salt of a branched chain dioctyl sulfosuccinate, the sodium salt of a branched chain dioctyl sulfosuccinate, the ammonium salt of a branched chain dinonyl sulfosuccinate, and the sodium salt of a branched chain dinonyl sulfosuccinate or mixtures thereof; and from about 70% to about 85% by weight of a low viscosity textile carrying agent.

Preparation of Oil Solutions of Basic Alkaline Earth Metal Petroleum Sulfonates, Patent No. 2,738,326 (H. W. Anderson, G. E. Warren & R. N. Bartholomew, assignors to Shell Development Co.) The method of preparing an oil solution of oil soluble basic calcium petroleum sulfonates which comprises continuously contacting a tertiary butyl alcohol solution containing from about 30% to about 40% by weight of an oil solution of oil soluble sodium petroleum sulfonates with an aqueous solution containing from about 20% to about 30% by weight of calcium chloride and containing from about 1.5 to about 2 molar equivalents of calcium chloride per equivalent of sodium sulfonate, whereby a tertiary butyl alcohol phase containing an oil solution of oil soluble neutral calcium petroleum sulfonates, and an equeous phase are formed; continuously separating the alcohol phase from the aqueous phase; continuously adding to said alcohol phase from about 0.75 to about 1.5 molar equivalents of calcium hydroxide per equivalent of sodium sulfonate, and a substantial amount of water, the amount of such added water being such that when the alcohol is removed from the mixture as is hereinafter provided, the resulting mixture contains from about 4 to about 8 per cent by weight of water; continuously removing said alcohol from the resulting mixture, and thereafter continuously removing the remaining water from the alcohol-free mixture, whereby an oil solution of oil-soluble basic calcium petroleum sulfonates is obtained.

Lithium-Strontium Soap Greases from Oxidized Petroleum Fractions Patent No. 2,738,327 (G. W. Eckert, assignor to The Texas Co.) A lubricating grease comprising essentially an oleaginous vehicle as the chief constituent thickened to a grease consistency with a mixed lithium-strontium soap of a saponifiable material obtained by the oxidation of a petroleum wax having a saponification number in the range from about 175 to about 450, said mixed lithium-strontium soap consisting of lithium and strontium soaps in a proportion by weight from about 1 to 4 to about 4 to 1, and containing free alkalinity in an amount equal to about 0.01 to about 10 per cent by weight of the grease.

Complex Grease Containing Hydrogenated Castor Oil, Patent No. 2,738,328 (A. J. Morway, assignor to Esso Research & Engrg. Co.) A lubricating grease composition comprising a major proportion of a lubricating oil and a grease-making proportion of a thickener consisting essentially of (1) a soap-salt complex of alkaline earth metal soap of at least one high molecular weight carboxylic acid and alkaline earth metal salt of at least one low molecular weight carboxylic acid, the molar ratio of low molecular weight carboxylic acid radical to high molecular weight carboxylic acid radical in said complex being in the range of about 7:1 to 40:1, and (2) hydrogenated castor oil, the weight ratio of said hydrogenated castor oil to said soap in said thickener being in the range of about 1:4 to 4:1.

Production of Greases Having Elevated Dropping Points, Patent No. 2,738,329 (G. A. Parry & J. B. Matthews, assignors to Shell Development Co.) In the process for the preparation of grease compositions wherein an alkali metal soap of a higher aliphatic monocarboxylic acid is heated with a lubricating oil to form a composition in a hot fluid condition and then cooled to a gelling temperature whereby a grease composition is formed, the improvement comprising adding a nitrite to said composition while it is in a not fluid condition.

Compounded Lubricating Oil, Patent No. 2,738,330 (M. W. Hill, assignor to Esso Research & Engrg. Co.) A motor oil composition for use in the lubrication of internal combustion engines employing leaded fuels, which contains a lead dispersing amount of a primary aliphatic mercaptan having in the range of 10 to 30 carbon atoms, said lead-dispersing amount being in the range of about 1 to 15% by weight based on the total oil composition.

Alkylthio Hydroquinones and Mineral Oil Compositions Thereof, Patent No. 2,738,331 (J. W. Brooks, assignor to Socony Mobil Oil Co., Inc.) A method for preparing an alkylthio-substituted hydroquinone which comprises reacting 1 mol of quinone with at least 1 mol of an aliphatic mercaptan in the presence of an acidic catalyst at a temperature of from about 0 C. to about 100 C. and for a time period of at least about 4 hrs.

Electrically-Conductive Drilling Fluids, Patent No. 2,739,120 (P. W. Fischer, assignor to Union Oil Co. of California). An oil-base drilling fluid comprising a mineral oil carrying suspended solids and sufficient of a dispersing agent to maintain said solids dispersed in said oil, between about 3 and about 10 per cent by weight of water, between about 0.01 and about 5 per cent by weight of an electrolyte selected from the class consisting of water soluble metal salts and alkali-metal hydroxides, and between about 0.1 and about 8 per cent by weight of a non-ionic surface active agent.

Thickened Hydrophobic Lubricating Compositions, Patent No. 2,739,121 (Adolf Weihe & Otto Schweitzer, assignors to Deutsche Gold- und Silber-Scheideanstalt vormals Roessler). A thickened lubricant comprising a lubricating oil thickened with highly dispersed finely divided compound in the form of an aerogel selected from the group consisting of oxides and hydrated oxides of silicon, titanium, aluminum and iron rendered water-resistant by the action of a compound which is capable of forming poly addition products with alcoholic hydroxyl groups selected from the group consisting of epoxy compounds containing a terminal ethylene oxide group, organic isocyanates, beta propiolactone, diketene and di-allylidene pentaerythritol acetal.

Antioxidant Compositions, Patent No. 2,739,122 (G. W. Kennerly & E. O. Hook, assignors to American Cyanamid Co.) An organic substance from the group consisting of mineral oils, diester synthetic lubricating oils and waxes normally liable to deteriorative effects due to the action of atmospheric oxygen having incorporated therein a synergistic antioxidant composition consisting of from about 0.001% to about 5% by weight of a tri-substituted mono-hydroxy phenol.

Antioxidant Compositions, Patent No. 2,739,123 (G. W. Kennerly & G. L. M. Christopher, assignors to American Cyanamid Co.) A composition comprising an organic substance from the group consisting of mineral oils and waxes subject to oxidative deterioration in organic substances due to the action of atmospheric oxygen and, as an antioxidant therefor, from about 0.0025% to about 5% by weight of comprising a synergistic material consisting of a 2,2'-alkylidenebis(4,6-disubstituted phenol).

Corrosion Preventive Oils, Patent No. 2,739,126 (L. S. Benbury & R. F. Connelly, assignors to Bray Chemical Co.) An anti-corrosive mineral oil composition comprising in major part a hydrocarbon mineral lubricating oil and a minor amount of a polyvalent metal sulfonate of the preferentially oil soluble type and about 0.01 to 1% of a synergistic agent consisting essentially of an oil soluble glycol of the class consisting of polypropylene and polybutylene glycols of about 500 to 3000 molecular weight.

Lubricating Grease Containing Organic Carbonates, Patent No. 2,739,127 (A. J. Morway, D. L. Cottle & D. W. Young, assignors to Esso Research & Engineering Co.) A lubricating grease comprising a major proportion of a liquid organic carbonate having the formula RO—CO—OR' in which R and R' are hydrocarbon radicals each having at least 8 carbon atoms, said carbonate having a pour point below 20°F. and a flash point above 300°F.; and about 5 to 40% by weight, based on the total composition, of a grease thickener selected from the group consisting of (1) metal soaps of high molecular weight fatty acids having 10 to 30 carbon atoms per molecule and (2) complexes of such metal soaps with metal salts of low molecular weight fatty acids, said metal being selected from the group consisting of alkali metals and alkaline earth metals.

Multiple Action Lubricating Composition, Patent No. 2,739,915 (L. K. Schuster & H. Aurand Whitenight). A relatively stable multiple action lubricating composition for application to a steel work piece substantially of ferritic crystal structure, to provide on the work piece both a chemically deposited coating capable of providing a high degree of separation of work and tool during cold working of the piece and an organic friction reducing substance.

Lubricating Oil and Process for Forming the Same, Patent No. 2,741,649 (A. D. Abbott & L. F. Brooke, assignors to California Research Corp.) In a process for converting a normally solid hydrocarbon wax to a lubricating oil, the steps comprising reacting said wax with an olefin of from 2 to 10 carbon atoms in the presence of a hydrocarbyl halide catalyst at a temperature between 400 and 700°F. and at a pressure between 100 and 15,000 p.s.i.g.; and separating from the resulting reaction mixture the constituents boiling below 250°F. at 1 mm. Hg as well as the unreacted wax; the residual oil obtained in this fashion being characterized by a viscosity index of at least 100 and by a pour point not greater than about 10°F.

Lubricating Oil Containing Dispersed Magnesium, Patent No. 2,742,427 (O. M. Reiff, assignor to Socony Mobil Oil Co., Inc.) A mineral lubricating oil composition, suitable for use in an internal combustion engine, having dispersed therein from about 0.1% to about 5% by weight of magnesium particles of a size no larger than about 45 microns.

Lubricating Oil Compositions, Patent No. 2,742,429 (G. M. Verley, assignor to Sinclair Refining Co.) A lubricating oil composition which consists essentially of a mineral lubricating oil base and a minor proportion sufficient to inhibit oxidation and corrosion of a lubricating oil additive soluble therein which is a pinene and phosphorus sulfide reaction product which has been modified by elevated temperature reaction with about 4% to about 8% urea.

Concentrates Useful as Additives in Mineral Oil Compositions and Mineral Oil Compositions Containing Same, Patent No. 2,742,430 (J. J. McBride, Jr., assignor to Tide Water Associated Oil Co.) A composition comprising a mineral oil in major amount based on the weight of the composition and a small amount, sufficient to inhibit said composition against the tendency to oxidize and corrode metals in contact therewith, of an oil soluble phosphorus-, sulfur-, and nitrogen-containing addition product of (a) a nitrile of an acid from the group consisting of propenoic acid and relatively low molecular weight alkyl-substituted propenoic acid and (b) an acidic phosphorous-, and sulfur-containing product of reaction between a phosphorus sulfide and a hydrocarbon.

Concentrates Useful as Additives in Mineral Oil Compositions and Mineral Oil Compositions Containing Same, Patent No. 2,742,431 (J. W. Bishop, assignor to Tide Water Associated Oil Co.) A composition comprising a mineral oil in major amount, based on the weight of the composition, and a small amount, sufficient to inhibit said composition against the tendency to oxidize and corrode metals in contact therewith, of an oil soluble phosphorus-, sulfur-, and nitrogen-containing addition product of (a) an amide of an acid from the group consisting of propenoic acid and relatively low molecular weight alkyl-substituted propenoic acids, and (b) an acidic, phosphorus- and sulfur-containing product of reaction between a phosphorus sulfide and a hydrocarbon.

Mineral Oil Lubricating Compositions, Patent No. 2,742,432 (N. V. Messina, assignor to Tide Water Associated Oil Co.) A lubricating oil composition comprising a mineral oil of lubricating grade in major amount based on the weight of the composition and a small amount, sufficient to impart rust preventive properties to said composition, of an additive comprising (1) an oil soluble half amide-aliphatic hydrocarbon ester of an aliphatic hydrocarbon dicarboxylic acid and (2) an oil soluble aliphatic hydrocarbon amine, said composition being characterized by containing said amine and half amide-ester in a weight ratio of one part of amine to from about one to about twenty parts of half amide-ester and said half amide-ester being characterized in that (3) its amide portion contains an aliphatic hydrocarbon substituent of about four to about twenty carbon atoms for at least one of the hydrogen atoms linked to the amide nitrogen atom and (4) its esterified portion contains an aliphatic hydrocarbon group of from about four to about twenty carbon atoms.

Stabilized Synthetic Lubricant, Patent No. 2,743,234 (A. H. Matuszak & E. V. Wilson, assignors to Esso Research & Engineering Co.) A synthetic lubricating oil composition which comprises a blend of from 20% to 95% by volume of a C_6 to C_{16} branched chain alcohol diester of a dibasic acid with from 80% to 5% by volume of a complex ester formed by reacting together at least three compounds of the group of alcohols, monobasic acids, dibasic acids and glycols containing combined therein from 0.1 to 2.0 weight percent, based on the weight of the total composition, of impure phenothiazine which has been prepared by heating

(Continued on p. 163)

Lubrication Abstracts

(Compiled by the ASLE Abstracts Sub-Committees.)

"Discussion of Phase Composition of Ball Bearing Steel & Its Management," by D. O. Koistinen, *General Motors Eng. J., Vol. 3,* No. 3, May-June 1956, pp. 10-13.

X-ray diffraction data is found to yield a simpler and more accurate empirical equation for calculating the percent retained austenite in hardened steel than data obtained using the usual technique of lineal analysis of photomicrographs. *(Abstracter: H. Connors)*

"Effect of Oil Volatility & Additives on Engine Octane Requirement," by F. S. Wood & C. C. Colyer, *Paper No. 868,* Soc. Automotive Engrs. meeting Nov. 8-9, 1956, 9 pp.

The antiknock quality of fuels which will satisfy the requirements of spark ignition engines is largely determined by the motor oil used, since both spark-knock and audible-surface ignition are influenced by combustion-chamber deposits generated by the motor oil. It is found that oil volatility, organic portions of lube oil detergents, organic portions of lube oil oxidation inhibitors, and viscosity-index improvers all have a marked effect on the engine's O.N. requirement regardless of differences in engine design, compression ratio, or type of engine operation. The findings are based on extensive laboratory tests and correlated with field tests. *(Abstracter: N. C. Penfold)*

"Efficiency of Three-Speed Bicycle Gears," by A. Thom, P. G. Lund & J. D. Todd, *Engineering, Vol. 182,* No. 4715, July 20, 1956, pp. 78-79.

An apparatus utilizing air-lubricated bearings for measuring the efficiency of hub-type epicyclic bicycle gears is described and test results presented. The gear efficiency in terms of output torque is given for three gear ratios; efficiency is reasonably constant at high torque but decreases rapidly below 3 lb.-ft.

"Glass Dispersions as Lubricants," by G. H. J. Munro, *Light Metals, Vol. 19,* No. 223, October 1956, pp. 327-328.

Glass films may be used to minimize oxide scale formation on stainless steel and titanium during preheating cycle, prior to hot working of metal. Films are deposited from semi-colloidal glass dispersions available in a variety of carriers. Exceptionally thin coatings frequently provide adequate lubrication during actual working operations. *(Abstracter: W. J. Wojtowicz)*

"Lubrication Problems in Hot Working of Aluminum," *Light Metals, Vol. 19,* No. 222, September, 1956, pp. 281-282.

A review of the factors which affect the selection of suitable lubricants for aluminum forging and die casting is presented. Among the most significant variables are: metal temperature, production rate, and method of application. The effect of die temperature on lubricant requirements is discussed. *(Abstracter: W. J. Wojtowicz)*

"Lubrication Systems for High-Performance Ball Bearings," by T. E. Rounds, *Machine Design, Vol. 28,* No. 19, Sept. 20, 1956, pp. 114-120.

Lubrication system requirements, speed and temperature influence on the choice between an oil or a grease, and descriptions of various types of lubricating systems are presented for precise, high-performance ball bearings operating at high speeds over wide temperature ranges. *(Abstracter: H. Connors)*

"Precision Machining in Miniature," by H. M. Dardani, *Machinery (NY), Vol. 63,* No. 1, September 1956, pp. 170-177.

A description of manufacturing procedures used in the new plant of Miniature Precision Bearings, Keene, N. H., is given. Emphasis is placed on specialized tooling and automatic machinery. Flexibility of tooling is more desirable than the rigidity of mass manufacturing techniques. Inner race blanks can be fabricated from three different materials using the same tool. Methods for assembling and checking miniature ball bearings are discussed. *(Abstracter: H. Connors)*

"Recent Advances in Miniature Instrument Bearing Technology," by O. M. Bergethon, *Paper No. 56-AV-28,* Am. Soc. Mech. Engrs. meeting March 14-16, 1956, 27 pp.

Current requirements for miniaturization in avionics design have resulted in increased emphasis on the need for instrument bearing components of better quality than traditionally available. Miniature bearings, one of the latest developments in the instrument ball bearing industry, are discussed from the standpoint of history, manufacturing, and application techniques, and performance evaluation. Future problems are also discussed. *(Absracter: H. Connors)*

"Warehouse Design, Layout & Material-Handling Equipment," by R. E. Thompson & W. J. Baral, *Proc. API, Vol. 35,* 1956, pp. 135-145.

Design, layout, and material-handling equipment are described in detail for a terminal warehouse for a large oil company. In addition to storage, the warehouse is to be used for compounding, packaging, and bulk-shipment of various types of lubricants and petroleum products. The design and equipment of small branch warehouses are also discussed.

American Society of Lubrication Engineers
Founded 1945
Chicago Illinois

This certifies that

John Doe

is a

Member

of this Society organized to promote the science and practice of lubrication and for acquiring and perpetuating that knowledge necessary to the lubrication engineer.

Administrative Secretary President

NOW AVAILABLE Restyled 8-½ x 11"

ASLE Membership Certificates

With name hand-lettered, and showing date of admission $1.50

Same as above, but suitably framed, ready for hanging $4.50

To order, indicate your preference; include your name and address, enclose remittance, and mail to:

ASLE, 84 E. Randolph St., Chicago 1, Ill.

(Patent Abstracts, from p. 161)

stoichiometric amounts of diphenylamine and sulfur to a temperature of about 190 to about 200°C. in the presence of iodine as a catalyst until evolution of hydrogen sulfide ceases, and from 0.001 to 5.0 wt. percent of an amine selected from the group consisting of primary, secondary and tertiary alkyl amines to prevent deposit formation from the commercial phenothiazine.

Mineral Oil Composition, Patent No. 2,743,235 (J. P. McDermott, assignor to Esso Research & Engineering Co.) A mineral lubricating oil having incorporated therein an oxidation inhibiting amount of a compound.

Synthetic Lubricants, Patent No. 2,743,275 (C. F. Feasley, W. E. Garwood, A. N. Sachanen & F. M. Seger, assignors to Socony Mobil Oil Co., Inc.) An oil of lubricating viscosity characterized by relatively high specific gravity, high viscosity index and low pour point and obtained by: condensing at a temperature between about 80°C. and about 140°C. for a period of time between about 5 hours and about 10 hours, one molar proportion of a normal alpha-mono olefin having from 8 to 18 carbon atoms per molecule, between about 0.01 and about 0.05 molar proportion of an organic peroxide selected from the group consisting of tertiary butyl peroxide and benzoyl peroxide, and from about 1 to 6 molar proportions of a heterocyclic compound selected from the group consisting of pyridine and alpha picoline, and separating said oil from the reaction product thus formed.

Synthetic Lubricants, Patent No. 2,743,280 (C. F. Feasley, W. E. Garwood, A. N. Sachanen & F. M. Seger, assignors to Socony Mobil Oil Co., Inc.) An oil of lubricating viscosity obtained by: condensing, at a temperature between about 80°C. and 140°C. for a period of time between about five hours and ten hours, one molar proportion of an alpha-mono olefin having from 8 to 18 carbon atoms per molecule with one molar proportion of thiophene and with 0.1 molar proportion of an organic peroxide selected from the group consisting of teritiary butyl peroxide and benzoyl peroxide, and separating said oil from the reaction product thus formed.

Synthetic Lubricants, Patent No. 2,743,281 (C. F. Feasley, W. E. Garwood, A. N. Sachanen & F. M. Seger, assignors to Socony Mobil Oil Co., Inc.) An oil of lubricating viscosity characterized by relatively high specific gravity, high viscosity index and low pour point and obtained by: condensing, at a temperature of about 85°C. for about nine hours, one molar proportion of n-decene-1 with one molar proportion of dioxane and 0.1 molar proportion of benzoyl peroxide, and separating said oil from the reaction product thus formed.

ASLE Preprints Available

A limited supply of the following preprints of papers presented at the ASLE-ASME 1956 Lubrication Conference are still available at 35c each to members, 50c each to non-members. To order, indicate the number of copies desired, fill in your name and address, enclose remittance, and mail to:

ASLE, 84 E. Randolph St., Chicago 1, Ill.

_____(56LC-7) *Application of Reaction Rate Theory to the Weld Junction Aspect of Kinetic Friction Between Unlubricated Metallic Surfaces,* by F. F. Ling & E. Saible

_____(56LC-1) *Application Problems with Petroleum Lubricants in Nuclear Power Plants,* by R. F. Hausman & E. R. Booser

_____(56LC-5) *Effects of Nuclear Radiation on Lubricants,* by J. A. King & W. L. R. Rice

_____(56LC-9) *Fretting of Hardened Steel in Oil,* by J. R. McDowell

_____(56LC-6) *Fundamental Study of Synthetic Sapphire as a Bearing Material, A,* by L. F. Coffin, Jr.

_____(56LC-2) *General Radiation Damage Problems for Lubricant & Bearing-Type Materials,* by V. P. Calkins & C. G. Collins

_____(56LC-18) *Influence of Temperature on Boundary Lubrication,* by C. W. Cowley, D. J. Ultee & C. W. West

_____(56LC-13) *Investigation of "Melt Lubrication,"* by B. Sternlicht & H. Apkarian

_____(56LC-10) *PbO & Other Metal Oxides as Solid Lubricants for Temperatures to 1000° F.,* by M. B. Peterson & R. L. Johnson

_____(56LC-4) *Radiation-Resistant Greases,* by J. G. Carroll, R. O. Bolt & B. W. Hotten

_____(56LC-8) *Solid Film Lubricant—Factors Influencing Their Mechanism of Friction & Wear,* by R. E. Crump

_____(56LC-12) *Solution for the Finite Journal Bearing & Its Application to Analysis & Design — II, A,* by A. A. Raimondi & J. Boyd

_____(56LC-16) *Specific Heat at Low Temperatures and Latent Heat of Fusion of Aircraft Engine Lubricants,* by V. E. Shrock & R. E. Gott

_____(56LC-11) *Temperature Effects in Journal Bearing Lubrication,* by W. F. Hughes & J. F. Osterle

_____(56LC-17) *Thermal Conductivity & Thermal Diffusivity of Aircraft Engine Lubricants at Low Temperatures,* by V. E. Schrock & E. S. Starkman

_____(56LC-3) *Use of Rolling Contact Bearings in Low Viscosity Liquid Metal Lubricants,* by W. Markert, Jr. & K. M. Ferguson

_____(56LC-14) *Yield Stress as a Factor in the Performance of Greases,* by D. Evans, J. F. Hutton & J. B. Matthews

Name_____

Address_____

City_____ Zone_____ State_____

Method of Preventing Oxidation of Oils in Electrical Equipment, Patent No. 2,744,038 (J. H. O. Lindhe, assignor to Aktiebolaget Nynas Petroleum). A method of rendering copper and iron surfaces of electrical equipment catalytically inactive towards oxidizable hydrocarbon mineral oils, which comprises treating the said metal surfaces with a mineral oil containing dissolved therein from about 0.002% to 0.5% of a phosphorous compound, calculated as phosphorous in per cent by weight of oil and selected from the class consisting of triisobutylphosphite, triisoamylphosphite and the corresponding triisothiophosphites, for a period of from about 1 to 5 hours and at a temperature between about 50 and 200°C., to form a phosphorous-containing coating on the metal surfaces, removing the phosphorous compound-containing oil from the apparatus and supplying an oil containing an alkylated phenol as inhibitor to the apparatus.

Odor Stabilized Lubricating Oil Additives, Patent No. 2,744,068 (J. D. Bartleson & H. E. Alford, assignors to The Standard Oil Co.) A method of preparing an additive which comprises reacting a mineral oil of lubricating viscosity with from 2 to 10% phosphorus sulfide at a temperature of 250 to 450° F. for from one-half to ten hours to form a lubricating oil additive, treating the additive with an alkali metal hydroxide followed by treatment with sulfur dioxide to provide an additive resistant to the development of hydrogen sulfide.

Compounded Lubricating Compositions, Patent No. 2,744,069 (Mintje van Loon, assignor to Shell Development Co.) A process for preparing lubricating oil additives which comprises reacting a mixture containing unsubstituted alkali metal alkyl phenates of from 14 to 32 carbon atoms and unsubstituted alkali metal alkyl salicylates of from 15 to 33 carbon atoms, wherein the weight ratio of the phenates to the salicylates is from 1:4 to 1:1, with a halide of a metal of group II of the

periodic table of elements having an atomic number from 12 to 56 in a monohydric water-miscible aliphatic alcohol of from 1 to 5 carbon atoms and containing water from 1 to 10% by weight of said alcohol, said halide being present in a quantity from 100 to 130% of that which is stoichiometrically equivalent to the total alkali metal content of said mixture of phenates and salicylates, and with an oxide of a metal of group II of the periodic table of elements having an atomic number from 12 to 56 in a monohydric water-miscible aliphatic alcohol of from 1 to 5 carbon atoms and containing water from 1 to 10% by weight of said alcohol, said oxide being present in a quantity from 90 to 150% of that stoichiometrically required for the formation of the mono-basic salts of said salicylates and said group II metal.

(Foreign Abstracts, from p. 145)

rough, semifinish, and finish machining conditions. Discussion of reasons for divergence of results obtained. (Order No. 3688, price $4.90)

Phosphating of Wire & Wire Rod Preparatory to Cold Drawing and Its Importance for the Wire Industry, by L. Kus; "Hutnik (Poland)," Vol. 22, No. 9, 1955, pp. 318-324; 5 figs., 6 tables, 1600-word condensation. Selection of best available preparation for continuous phosphating operations at wire mills. Data on best-known German (6) and Russian (1) compositions for fast phosphating baths (Tables I & II) for (a) starting new baths, and (b) regenerating used baths; method of preparing baths. Procedure for selecting the most favorable phosphating bath and phosphating conditions (bath temperature; bath concentration; immersion time, etc.) giving optimum results. Drawing experiments on phosphated steel wire and rod (0.08 to 0.75% C); die diameters and percent reductions (Table V). Drawing force required (Table VI) for phosphated as against nonphosphated wire and rod, and surface qualities obtained (Figs. 2-5). (Order No. 3717, price $3.80)

Nature of Plastic Deformation of Surface Zones of Working Parts, by K. V. Savitskii & M. P. Zagrebennikova; "Doklady Akademii Nauk SSSR," Vol. 103, No. 4, 1955, pp. 605-608; 4 figs., 1400 words. Comparative study of changes in microhardness of surface zones of Cu and Al cylinders, after friction against steel plates, and after 30-60% compression under static and dynamic loads. Degrees of strain hardening induced by deformation of thin surface layers. Effect of annealing temperature on microhardness as a measure of recovery through annealing, and of the resistance of internal distortions to such recovery. Interpretation of results; possibility of simultaneous strain hardening and recovery. (Order No. 3765, price $2.90)

Sulfidizing of Chromium Stainless Steels, by E. P. Pukhovskii et al; "Metallovedenie I Obrabotka Metallov," Vol. 2, No. 5, 1956, pp. 40-43; 5 figs., 3 tables, 1200 words. Advantages of sulfidizing especially for improved frictional wear resistance of stainless steels. Effect of pack sulfidizing in 3 different mixes of graphite, ferrous sulfide, and potassium ferrocyanide at various temperatures (560, 650, and 750° C.) for various lengths of time (up to 24 hours) upon wear resistance of 13% Cr steels with 0.10, 0.20, and 0.30% C. Experimental procedure for sulfidizing and wear testing; determination of wear index used in study. Depth of S-impregnated zone. Interpretation of results of wear tests on sulfidized and unsulfidized specimens. Wear resistance of sulfidized steels other than stainless (0.30% C plain steel; 0.40% C, 1% Cr, 0.4% Ni steel). (Order No. 3799, price $2.90)

(Current Lit., from p. 156)

cosity-Neutralization Number, by J. B. Christian, V. A. Lauer, A. L. Miller & H. M. Schiefer, Wright Air Dev. Center, U. S. Air Force; April 1956, 19 pages. A study was initiated to develop miniaturized tests for petroleum, petroleum products, and related materials, samples of which are sometimes received by analytical laboratories in insufficient quantity for evaluation. This report, the first of a series, describes procedures for determining neutralization number and viscosity and their correlation with macro tests. The small-scale techniques are said to be as effective in purpose as their full-scale counterparts. (Order No. PB-121355, price 50¢)

Polyarylurea Greases, by D. T. Kjerland, Wright Air Development Center; July 1956, 19 pages. In previous research, arylurea compounds with good grease-thickening characteristics were prepared from aromatic isocyanates or aromatic diisocyanates and an aromatic amine or combination of aromatic amines. This report deals with formation of polyarylurea greases through use of aromatic diamines and aromatic diisocyanates as reactants. Preliminary data showed polyarylureas to have much better thickening ability than simple arylureas with equivalent heat stability. (Order No. PB-121531, price 50¢)

Foaming Characteristics of Aircraft Oils, by G. Baum, Wright Air Development Center; May 1956, 16 pages. Foaming characteristics of several lubricating oils and a number of defoaming additives were investigated between 1949 and 1956 in a project to alleviate difficulties in piston engine aircraft attributed to oil foaming. Although no successful defoamers for light oils were developed, silicone- and sorbitan-type additives were found effective for heavy petroleum oil. A laboratory test was devised with a sharper delineation between a group of oils than the currently used ASTM test. With refinement, the procedure may provide a better index of foaming tendencies of oils, according to the report. (Order No. PB-121445, price 50¢)

Antiwear & Extreme-Pressure Additives for Greases, by S. F. Calhoun & G. P. Murphy, Rock Island Arsenal Lab., U. S. Army Ordnance Corps; March 1955, 27 pages. Antiwear and extreme-pressure properties of 27 additives to lithium soap-mineral oil greases were evaluated as part of research concerned with fortification of lubricants against increasingly severe conditions imposed by modern machinery. General trends indicated that additives containing phosphorous gave best antiwear properties, while those containing sulfur were superior against extreme pressure. It was found that two or more additives could be blended to attain improvements in both antiwear and pressure properties. Optimum antiwear and pressure qualities seemed to depend on factors not contained in the additive, such as oil viscosity, soap type and amount, and conditions of service. (Order No. PB-111919, price 75¢)

High-Temperature Antioxidants for Synthetic-Base Oils (5 parts, see below). Extensive Air Force-sponsored research leading to development of new antioxidants for synthetic lubricants used under high temperatures is described. The volumes review research conducted from 1953 to 1955 by J. W. Cole, Jr. and others at the University of Virginia for Wright Air Development Center.

GENERAL MANAGER WANTED

General Manager required for a grease and lubricant manufacturing plant to supervise all marketing, manufacturing, and research. Sales experience essential. Compensation will be in line with this difficult job. Our employees know about this ad. Write Box LE-357.

Lubrication Engineering, 84 E. Randolph St., Chicago, Ill.

Lubrication Engineer AVAILABLE

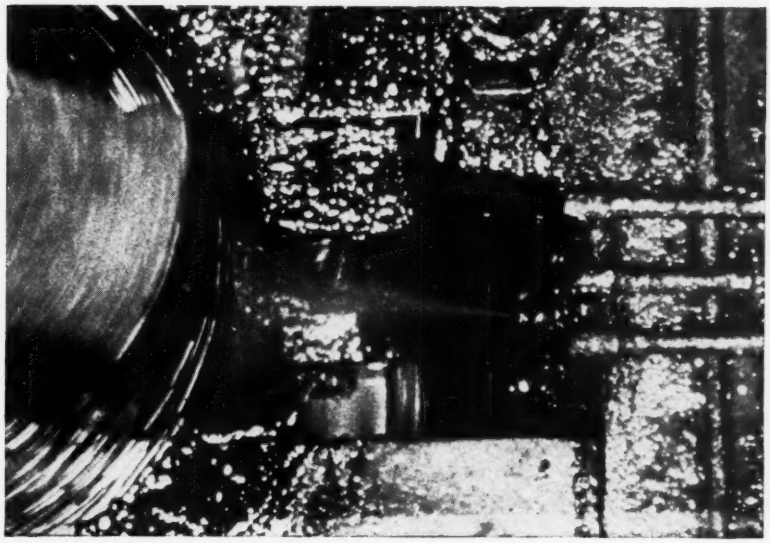
For high-level executive position in lubrication engineering. Broad professional experience in lubrication and in mechanical, chemical, nuclear, electrical, metallurgical fields, and in transport — R.R., marine, air. $20,000 minimum. Write Box LE-457.

Lubrication Engineering, 84 E. Randolph St., Chicago, Ill.

THE BROOKS OIL CO.

Lub-Engineering News

A REPORT ON THE DIFFICULT LUBRICATING PROBLEMS OF INDUSTRY



SPRAY LUBRICATION OF ROLL NECK BEARINGS CUTS COSTS FIVE WAYS, STEEL MILL REPORTS

Lubrication of roll necks and bearings by means of a spray system employing a fluid lubricant, as shown in the unretouched photograph above, has proved far superior to the traditional system of forcing grease along grooves machined in the bearing surfaces, according to reports of an extended study recently completed by a major steel company.

Five major savings resulted from the use of the spray system:

1. The initial cost of preparing the bearings for service was reduced because it was not necessary to cut grease grooves. Also, the safe overall bearing area is substantially increased.
2. Lubricant consumption dropped from an average of 20 drums per week to approximately 3 drums.
3. Bearing life was substantially increased. With the old system of lubrication, bearings wore out in about 3 weeks. Bearings lubricated by the spray system showed no appreciable wear after 18 weeks of service.
4. Longer bearing and roll neck life also meant less time and cost for remachining and dressing.
5. Mill downtime was greatly reduced. With ordinary lubrication, 5 intervals of downtime would have been expected during the four months of the study period—with spray lubrication there was *no* downtime—saving thousands of dollars.

First adapted in 1949 and now being used by major steel companies for this important and severe application—the lubricant was Brook's Klingfast, a lead base fluid lubricant which retains its film strength (4 gram Timken test, 30 min. minimum—43 lbs. L.A.L.).

For complete data, write for Bulletin K-26-LE.

NEW COLOR FILM GIVES ANSWERS TO TOUGH LUBRICATION JOBS

Want to see how good lubricants get that way—lubricants for severe industrial applications, that is?

This new 30 minute 16 mm motion picture, in full color, with sound, shows a number of tough lubrication jobs. It pictures and describes the research, manufacturing and quality control methods that enable Brooks lubricants to "stand up" under severest service.

It's available to any supervisory or engineering group interested in lubrication problems. No charge, of course—we're glad to have you see it. Just call or write any of our offices and tell them you want to borrow "The Brooks Oil Story."

HAVE YOU TRIED Klingfast® FOR OPEN GEARS?

Lubrication of open gears is one of industry's toughest jobs because of severe operating conditions in speed, vibration, shock, reversal, intermittent action, exposure to high temperature, contamination, and the added problems of inaccurate alignment, excessive clearance in bearings and incorrect contact of teeth surfaces. If you've been having open gear lubricating problems, write us about Klingfast. This lubricant has been the answer in many case studies.

BROOKS LABORATORIES ARE AT YOUR SERVICE

Extensive research is constant with Brooks. Our laboratories are available at all times, with experienced and qualified personnel to serve your lubrication research and development needs.

THE BROOKS OIL CO. 81st YEAR 1876 1957

THE BROOKS OIL COMPANY

EXECUTIVE OFFICES AND PLANT—CLEVELAND, OHIO

EXECUTIVE SALES OFFICES—928 RIDGE AVENUE, PITTSBURGH 12, PA.

OFFICES AND WAREHOUSES IN PRINCIPAL CITIES

U.S.A.
CANADA
CUBA-S.A.
EUROPE

ASLE MEMBERSHIP CLASSIFICATIONS

Membership in the American Society of Lubrication Engineers is in several grades as defined below. Assignment to grade is made by the Admissions Committee or Board of Directors on the basis of information submitted or supplied by references.

Members: Members shall be persons not less than 24 years of age who: (1) are engaged in research and instruction at technical schools, universities, and various publicly and privately supported institutions in the field of lubrication; or (2) have occupied recognized positions as lubrication engineers for a period of three or more (not necessarily consecutive) years prior to date of admission, involving the responsibilty for or supervision of the development, selection, field use and application of lubricants as differentiated from other activities; or (3) are indirectly concerned with the field of lubrication, but possessing other qualifications of experience, knowledge, and accomplishment, and have manifested a particular interest in the purposes and welfare of the Society to the extent that their membership would be a valuable contribution to the successful functioning of its activities. Fee $15.00.

Associate Members: Associate Members shall be persons less than 24 years of age, and those who do not completely fulfill the membership requirements for Members. Fee $7.50.

Sectional Sustaining Members: Sectional Sustaining Members are such persons or organizations as may be interested in and desire to contribute to the support of the purposes and activities of a local Section of the Society. Fee $25.00.

Industrial Members: Industrial Members are such persons or organizations as may be interested in and desire to contribute to supporting the purposes and activities of the Society. Fee $150.00.

For application blanks or further information, write:

ASLE
84 E. Randolph St.
Chicago 1, Ill.

Part 1, "Testing Methods & Preliminary Results," Oct. 1953, 135 pages. (Order No. PB-121077, price $3.50)

Part 2, "Evaluation of Additives, Syntheses of New Compounds & Mechanism Studies," Dec. 1953, 177 pages. (Order No. PB-121078, price $4.50)

Part 3, "The Thermal Decomposition of Di(2-ethylhexyl) Sebacate," Dec. 1953, 41 pages. (Order No. PB-121079, price $1.25)

Part 4, "Studies in the Copper-Phenothiazine-Di(2-ethylhexyl) Sebacate System in the Neighborhood of 200° C. (400° F.)," Dec. 1953, 48 pages. (Order No. PB-121080, price $1.25)

Part 5, "Evaluation of Additives, Synthesis of New Compounds & Mechanism Studies," March 1955, 217 pages. (Order No. PB-121081, price $5.50)

(New Products, from p. 121)

slushes, and is especially economical when mixed with water. (Data Sheet No. 2-459, E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33, Pa.)

Grinding Coolant Filters. Six new filters with capacities of from five to sixty gallons per minute for filtering heavily contaminated grinding machine coolants have been announced. The accordion-pleated, plastic-impregnated filter elements trap particles down to a size of 10 microns. Capable of removing either ferrous or nonferrous metal particles, the new filters prevent scratching of parts being ground, and provide protection for internal pump parts from metallic particles and abrasives. Available in capacities for handling 5, 10, 20, 30, 40, or 60 gallons of water-soluble oil and lapping coolants per minute (halve each amount to figure capacity of filter for thread-grinding coolants), the filters largely eliminate production stoppages for purposes of cleaning tanks and changing coolants. (Purolator Products, Inc., Dept. G, Rahway, N. J.)

Petroleum-Handling Hose. Four new types of dock hose have been developed to meet the need for petroleum-handling hose that is lightweight and long wearing. Boston Aluminum has been introduced to provide a suction and discharge hose that combines extremely long service life and toughness with ease of handling; it operates under pressures of up to 200 lbs., yet weighs only 8 lbs. per ft. Boston Bull Dog 200 is a rough bore hose used for heavy-duty loading or unloading operations. Where low weight is of prime importance, Boston 100 Lightweight discharge hose boasts a weight of only 3.7 lbs. per ft. Boston 200 Lightweight has been built for moderate duty dock service where application is for discharge service only. (Boston Woven Hose & Rubber Co., P. O. Box 1071, Boston 3, Mass.)

Multi-Purpose Lubricant. A new multi-purpose lubricant has been announced that will do an outstanding job not only in chassis lubrication, but also in the lubrication of wheel bearings, water pumps, fifth wheels, track rollers, grease types of universal joints, and ball and roller bearings. The lubricant is water repellent, offers protection against rust, and does an excellent job in high-temperature operation. With the availability of this new product the company is discontinuing the manfacture of Atlantic Chassis Lubricant, Lubricant A, and Water Pump Lubricant. (The Atlantic Refining Co., 260 S. Broad St., Philadelphia 1, Pa.)

Parker O-Ring Compound. A recent SAE specification designated AMS-3357 calls for a silicone material that has lubrication oil resistance and good compression set qualities, and that is suitable for a temperature range of minus 65 to plus 450° F. Evaluation tests by the company indicate that Parker O-Ring Compound 77-018 fully meets the requirements of this specification. (Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.)

Filter Cartridge. Tuflite, a new filter material consisting of graded cotton fibers melted into sheets and impregnated with a thermosetting plastic resin, has been designed for high flow rate and low pressure drop, and for removing particle sizes down to 5 microns. Suitable for fine filtration of all

types of lubricating, fuel, and industrial oils, and many aqueous solutions such as coolant compounds, they are made in a rigid assembly to avoid sagging and shrinking. (The Hilliard Corp., Purifier Div., Elmira, N. Y.)

(Personals, from p. 119)

trial and agricultural piping systems.

E. I. duPont deNemours & Co., Petroleum Chemicals Div., Wilmington, Dela., has announced the following appointments: W. W. Wingate and **R. O. Braendle** (ASLE Philadelphia Section) as Assistant Manager and Additives Manager, respectively, of the Mid-Continent Region; B. B. Russell, as Assistant Manager of the Gulf Coast Region; and J. G. McIlhiney, as Denver District Manager.

P. J. Fossey has joined the senior sales staff of American Potash & Chemical Corporation's British subsidiary, Borax & Chemicals, Ltd.

R. Q. Sharpe (ASLE New York Section), Staff Engineer of the Industrial Div. of the Lubricating Dept. at Socony Mobil Oil Co., Inc., New York City, has been appointed Chief Engineer of the department.

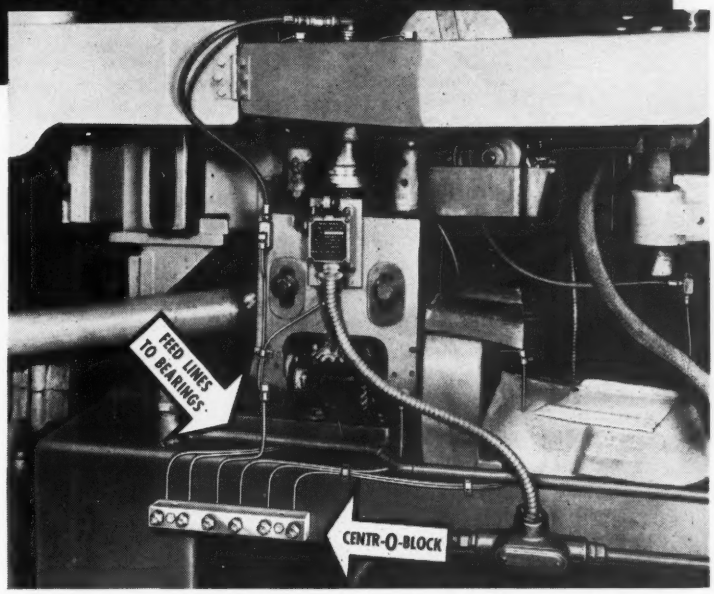
F. W. Montanari, a Sanitary Engineer associated with the Institute of Inter-American Affairs for the past eleven years, has been appointed to the staff of the Ohio River Valley Water Sanitation Commission, Cincinnati, Ohio. Mr. Montanari comes to the interstate agency from Panama where he acted as Consultant in the development of sanitation installations sponsored by the Point IV technical-assistance program in Latin America. His current assignment will be related to the evaluation of industrial wastes and the development of control measures.

(Section News, from p. 140)

January. "What Management Expects of the Lubrication Department," by R. A. Kraus, Republic Steel Corp. (Submitted by S. J. Litten, Sec'y-Treas.)

NOW . . . lubricate even smallest machine units in seconds . . .
from one central point!

***Lincoln* CENTR-O-BLOCK**
LUBRICATION SYSTEMS CENTRALIZE ALL GREASE FITTINGS AT ONE POINT FOR FASTER, CLEANER LUBRICATION!



Lincoln Centr-O-Block System installed on machine unit, showing manifold block and feed lines to bearings.

This practical, easy-to-install method of centralized lubrication permits you to include even the smallest machine unit in a *standardized* lubricant application program . . . at rock-bottom cost.

The system consists of one or more manifold blocks bolted to the most easily accessible location on machine. Rigid or flexible feed lines connect bearings to outlets in blocks. Inlet ports of blocks are threaded for insertion of standard ⅛" P.T. Surface-Check or conventional hydraulic lubrication fittings. Fittings can then be contacted by any standard manually or power-operated application device such as lever guns, bucket pumps or power lubricators.

All bearings contacted in seconds from *one central point!* This reduces lubrication man-hours, eliminates "over-looking" one or more points of contact, prevents accidents, and permits lubrication without machine shutdown.

No special preparation for installation, no special tools needed. Nothing extra to buy. All components to complete installation listed in Lincoln Bulletin No. 681-A. Write for it today!

Lincoln
THE MOST TRUSTWORTHY NAME IN LUBRICATING EQUIPMENT

LINCOLN ENGINEERING COMPANY
Division of The McNeil Machine & Engineering Co.
5743 Natural Bridge Ave. St. Louis 20, Mo.

ASLE Publications
ORDER BLANK

Interpreting Service Damage In Rolling Type Bearings

A manual on ball and roller bearing damage which includes drawings, tables, and 74 photographs for aiding in the classification and identification of the causes of many of the common types of bearing damage. $1.00 per copy.

"Lubrication Engineering" Decennial Index

Subject & Author Indexes listing the papers published in **Lubrication Engineering**, Journal of the American Society of Lubrication Engineers, in Volumes 1 thru 10 (1945 thru 1954). 50c per copy.

Petroleum-Type Hydraulic Fluids

Second in the series of ASLE monographs, covering Hydraulic Oil Specifications & Service Properties, Viscosity, Viscosity Index, Demulsibility, Oxidation Stability, Lubricating Value, Rust & Corrosion Preventive Qualities. $1.00 per copy.

Physical Properties Of Lubricants

First in the series of ASLE monographs, covering Viscosity, Density & Specific Gravity, Cloud & Pour Points, Flash & Fire Points, Carbon Residue, Neutralization Number & Interfacial Tension, Saponification Number, Emulsification, Specific Heat. $1.00 per copy.

Practical Lubrication, Vol. 1

Ten practical articles giving information fundamental to the carrying out of successful lubrication practices in industry: Cleaning Lubrication Systems, Coal Mine Lubrication, Grease Lubrication of Ball Bearings, Lubricating Grease, Lubrication Requirements of Gears as Seen by a Gear Engineer, Open Gear Lubrication, Planned Lubrication as a Part of Plant Maintenance, Reduction of Gear Failures, Seals & Closures, Steel Mill Lubrication from Management's Point of View. $1.00 per copy.

Indicate opposite title the number of copies desired, fill in your name and address, enclose remittance, and mail to:

ASLE, 84 E. Randolph St., Chicago 1, Ill.

Name .....

Address .....

.....

(Please Print)

Advertisers' Index

Acheson Colloids Co. 120
Alemite Div., Stewart-Warner Corp. 118
Alpha Molykote Corp., The 122
American Potash & Chemical Corp. 115
Baroid Div., National Lead Co. 157
Brooks Oil Co., The 165
Bryton Chemical Div., Continental Oil Co. 124
Emery Industries, Inc. ..... 158 & 159
Farval Corp., The ..... (Inside Front Cover)
Hodson Corp., The ..... (Back Cover)
Lincoln Engineering Co., Div. of The McNeil Machine & Engineering Co. 167
Norgren Co., C. A. 126
Sun Oil Co. ..... 116A & 116B
Trabon Engineering Corp. ..... (Inside Back Cover)
Tuthill Pump Co. 128

Classified ..... 164 & 168

ASLE JEWELRY

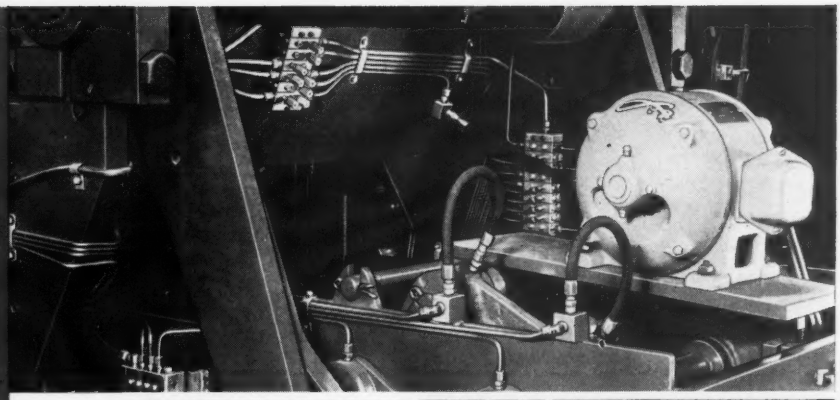
The new ASLE jewelry is available in the form of tie clasps, lapel pins, or cuff links at $3.50, $1.50, and $4.50 each, respectively, from the National Office. Many of the Sections are using the jewelry in their membership campaigns. Details are available through the National Office.

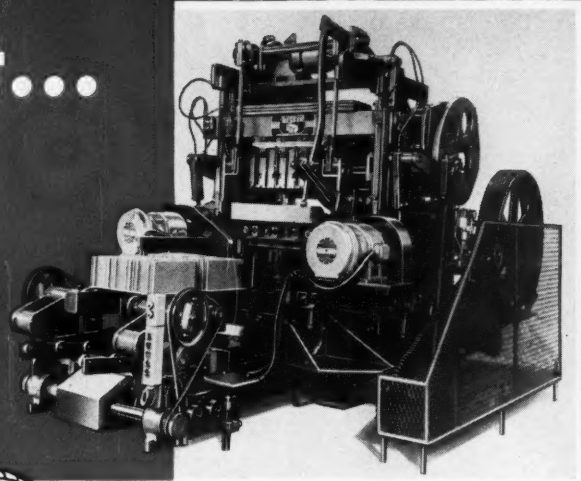
GENERAL MANAGER WANTED

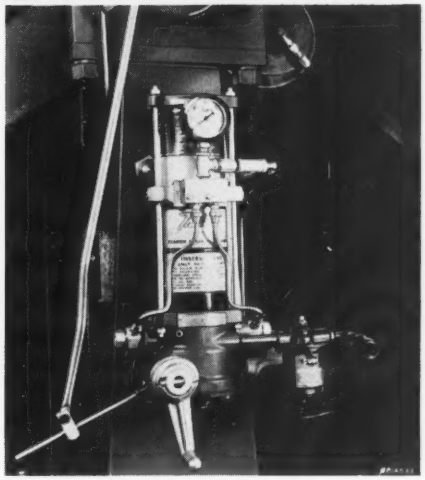
General Manager required for a grease and lubricant manufacturing plant to supervise all marketing, manufacturing, and research. Sales experience essential. Compensation will be in line with this difficult job. Our employees know about this ad. Write Box LE-357.

Lubrication Engineering, 84 E. Randolph St., Chicago, Ill.

it's a dirty job but...







all 73 bearings get clean grease automatically

Cement dust, gritty sand, and water threaten the bearings of a concrete block machine. That's why the Besser Company uses Trabon Centralized Lubrication Systems on their Vibrapacs.

Measured amounts of clean grease flow through the completely sealed Trabon system to every bearing. Geared to the machine, the Trabon Pump automatically keeps time with the Vibrapac's speed of operation. There's no undergreasing or overgreasing.

Vibrapac owners welcome the extra production time gained by eliminating hand greasing. Serious bearing failures have been eliminated, too. If a bearing should stop receiving lubricant for any reason, a warning light tells the operator there's trouble. Trabon is the only system that offers this valuable safety feature.

Trabon Centralized Oil or Grease Systems are installed on every type of equipment. If you don't have a Trabon System on your machines, it will pay you to check further. Write for details.

Trabon "Centralized" **OIL AND GREASE SYSTEMS**

"Meterflo" **CIRCULATING OIL SYSTEMS**

Trabon **ENGINEERING CORPORATION**

28815 AURORA ROAD • SOLON, OHIO

Oil and Grease Systems

ATTENTION

WHEN "RUN OF REFINERY"

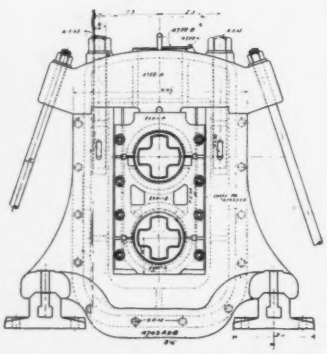
PRODUCTS FAIL

USE

"FOUR HORSEMEN"® PRODUCTS

By

HODSON



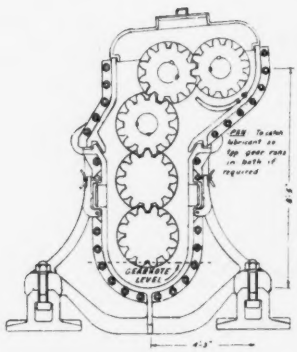
DENSOIL Lubricated

IT COSTS MORE

NOT TO USE

"FOUR HORSEMEN"®

PRODUCTS



GEARKOTE® Lubricated

The HODSON CORPORATION

Lubrication

5301-11 WEST SIXTY-SIXTH STREET

CHICAGO 38, ILLINOIS

3-L-57

PRINTED IN U.S.A.